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THE ART OF

SOAP-MAKING

A PRACTICAL HANDBOOK

OF

THE MANUFACTURE OF HARD AND SOFT SOAPS,
TOILET SOAPS, ETC.

BY ALEXANDER WATT

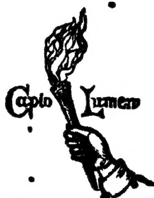
AUTHOR OF "ELECTRO-METALLURGY PRACTICALLY TREATED," "THE ART OF LEATHER MANUFACTURE," ETC.

With Numerous Illustrations

SIXTH EDITION

INCLUDING

AN APPENDIX ON MODERN CANDLE-MAKING



LONDON

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PREFACE.

In compiling this book, the Author has endeavoured to fill a void in English technical literature. While almost every art is represented by treatises or handbooks of a more or less practical character, Soap-making, so far as the Author is aware, has not until the present time been furnished with a special book of reference for the convenience of its numerous followers. In the United States, however, several elaborate treatises of foreign origin have appeared, and to these the author has been indebted for much valuable information, especially as regards the Continental methods of making ordinary soaps and toilet soaps, given by Dussauce, Cristiani, Ott, and Kürten.

An important feature in the present volume is the chapter on the Recovery of Glycerine from Waste Leys, in which many processes for recovering this valuable product are given.

Although it would not have been possible nor even desirable to include every known process of soap-making, a great number of processes in an abridged form are given, which cannot fail to be useful to the manufacturer.

To write an original work upon an art which has been

built up, so to speak, by the ingenuity of the great host of inventors and patentees, would be an impossibility: the present work, therefore, must be accepted as an epitome of their collective processes and improvements rather than as an original treatise, and the Author trusts that in his endeavour to produce a work which would be useful both as a practical handbook and source of general reference, he may not have been wholly unsuccessful.

PUBLISHERS' NOTE TO THE FIFTH EDITION.

THE present edition of this work is substantially a reprint of the last edition, with a new Appendix (left by Mr. Watt in MS., and now first printed) on the subject of CANDLE-MAKING, which, with its illustrations, it is believed will be found a very useful and acceptable addition. Owing to the death of Mr. Watt a few months after the preparation of the last edition, the work has not undergone any further revision at his hands, though the opportunity has been taken of making a few corrections in the text, for which the Publishers are indebted to Mr. H. Joshua Phillips, F.I.C. However, from the continued and large demand for the work, it is abundantly evident that, as revised and enlarged by the Author, the volume amply fulfils the purpose with which it was designed.

LONDON, *October*, 1895.

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THE ART

OF

SOAP-MAKING.

INTRODUCTION.

According to the great Roman historian, Pliny, the Gauls were the original inventors of the art of soap-making—their best product being a combination of goats' fat and the ashes of the beech-tree. The Romans subsequently acquired a knowledge of the art, and eventually introduced it into Italy after their successful invasions of Gaul. In proof of the antiquity of soap as an article of commerce, a soap-maker's shop has been discovered in the ruins of Pompeii, and is still exhibited to travellers.

Prior to the invention of soap, the ancients employed the juices of certain plants as detergents, and also fullers'-earth, which was first spread upon the surface of their clothes, and then stamped in by the feet. By this means greasy matter was removed on subsequent scouring, the fullers'-earth having the property of absorbing grease to a considerable extent. Sometimes this earth was employed as a cleansing medium in baths, and even up to the beginning of the eighteenth century this system was adopted in Rome by persons of the highest distinction.

In the eighth century there were many soap manufactories in Italy and Spain, but it is a remarkable and interesting fact that nearly five hundred years elapsed ere soap manufacture was introduced into France and practised as an art by the Phoceans, an intelligent and industrious race, of Grecian and Egyptian origin. The first soap manufactories in France were established at Marseilles, a city surrounded with natural advantages of soil and climate for the production of all the crude mate-

rials necessary for soap-making. The olive-tree, the fruit of which yields a fixed oil in great abundance, flourished in the south of France, while the shores of the Mediterranean yielded an ample supply of maritime plants, from which crude soda was obtained by calcination. Marseilles, however, with all these advantages, was unable to produce sufficient material to meet the demands of her manufacturers; therefore, as time progressed, Italy furnished supplies of olive-oil, while Spain contributed crude soda, or *barilla*.

The manufacture of soap in France was entirely confined to the combination of olive-oil and soda until the beginning of the present century, when palm-oil and cocoa-nut oil were also employed in the art, and subsequently toilet, or fancy soaps, were introduced, and ultimately formed an extensive and important addition to the soap trade.

The exact period at which soap was first manufactured in England appears somewhat uncertain, but it was probably in the fourteenth century, when it was chiefly made upon the French system, that is to say, with *barilla* (crude carbonate of soda); and some other manufacturers adopted a method practised in Germany, in which potash, followed up by salt, superseded the use of soda obtained by the calcination of maritime plants.

We find that the first patent for improvements in the manufacture of soap was obtained in 1622, by Messrs. Jones and Palmer, an abridgment of which is given below:

"The misterie, arte, way, and means of makinge of hard soape, comonly called by the name of Venice or castile soape, without the vse of anie fire in the boyling or makinge thereof, and with a materiall comonly called or known by the name of berillia, and The art, misterie, way and means of makinge of softe soape without the vse of fire in the boylinge and makinge thereof."

From the above period up to the present time, many patents for important improvements in soap-making have been taken out in England.

Having passed through a long period of rude and unscientific manipulation, the art of soap-making at last—namely, at the beginning of the present century—commanded the attention of scientific men, and the world was startled first by Leblanc's splendid process for the manufacture of soda from common salt, which process was practically developed in this country by the late Mr. James Muspratt, of St. Helen's, near Liverpool. The advantages of this invention are far beyond estimation, and although it has since been superseded to a certain extent by the ammonia process, it can never be forgotten that its introduction did more for the soap and glass manufacturer than any other invention under the sun.

The next great discovery, though not second in importance, was due to another French chemist—Chevreul—who raised soap-making from empiricism and rule-of-thumb guesswork to its present exalted position as a truly scientific art. With the rapid advance of chemical knowledge which followed the discoveries of Davy, Dalton, Chevreul, and other English and foreign chemists, the art of soap-making gradually improved, and many saponifiable substances were introduced from time to time, until, at the present day, the lengthy list includes oils and other fatty matters which were never dreamed of by our forefathers. It would not be incorrect, however, to say that up to forty years ago soap manufacture was generally conducted without any reference to scientific principles or chemical theories. Except in very rare instances, the aid of science was never consulted, and the operations were frequently carried on by persons absolutely void of even the rudiments of chemical knowledge. Indeed, the manufacturers were so completely in the power of their soap-boilers that any attempt to recognise an improvement, by giving it a fair trial, was invariably opposed and frustrated by the so-called "practical man." At the time we refer to, the prejudice against chemical interference, if we may so call it, was so great, that even scientific men of the highest ability

were spurned, and their attempts to improve the crude art were foiled in every possible way. There were, however, a few exceptions to the general rule (of thumb), and several large firms—notably the firm of Benjamin, William, and Thomas Hawes, of Lambeth—who dared to admit the teachings of science within their portals. Not only did these manufacturers encourage improvements based upon chemical principles, but they also employed chemists in their works, who, furnished with a laboratory and appliances, soon converted the operation of soap-making into an art, in the proper sense of the term. The estimation of the actual amount of alkali in a given sample of soda-ash was determined by their own chemist, in many instances indicating a wide difference when compared with the analysis of the alkali-broker's chemist. All "goods" were subjected to examination by the soap-maker's analyst before purchase, and thus the intelligent manufacturer was protected from fraud and imposition, which gave him an incalculable advantage over his unaided competitors.

Although the great French chemist, Chevreul, had clearly explained the nature of the reactions which take place when fatty substances are treated with boiling solutions of caustic alkali, few soap-makers would venture to modify their antiquated system of manufacture by calling to their aid the man of science. The soap-maker's argument seemed to be: "My soap has a large sale, it yields a good profit; what more can I require?" If the chemist told him that he was liberating a large portion of glycerine, which flowed away with his waste leys into the river or sewer, instead of being recovered, and he was thereby losing a large sum annually, the soap-maker cared not, for he still had a good profit on his soaps.

In 1836, the author's father, the late Mr. Charles Watt, patented his now well-known process for bleaching palm-oil by means of chromic acid; but it was not until several years after that soap-makers "took up" the process and adopted it. So great was the prejudice against

any and all improvement, that even a trial of the process was for a time rejected; and when at last the trade were induced, after some of the more intelligent firms had become licencees under the patent, to give the process a trial, not unfrequently would the workmen put raw (that is, unbleached) palm-oil into the batch which had been operated upon, during the patentee's absence, so that their employers might denounce the demonstration as a failure. In at least one instance a trick of this kind was practised upon the author, who for many years conducted the operation of bleaching palm-oil, on his father's behalf, in London and the provinces.

Referring to the importance of chemical knowledge in soap manufacture, Mr. William Hawes, in a paper which he read before the Society of Arts on the 28th of March, 1856, stated that 6,000 tons of tallow were converted into glycerine annually, causing a loss of about £180,000, and there is no doubt whatever that the whole of this waste could be avoided by manufacturing soap by the cold process, or at all events this valuable product should be recovered as hereafter described. At the present day, in most of the larger soap-works, the teachings of science are not only recognised, but an experienced chemist is engaged, under whose skilful guardianship the various operations are conducted. In some instances the sons of members of the firm have been properly instructed in chemical knowledge, and to them are instrusted the scientific details of this strictly chemical art. In some establishments, the principals, or at least one of them, have acquired sufficient knowledge of chemistry to enable them to conduct their operations *with a knowledge of what they are doing;* so that we may now say that at last science and soap-making go hand in hand, except in a few instances where the British workman is still looked upon as an idol.

Another important feature in the manufacture of soap was the application of steam, and superheated steam, in place of the ordinary fire. Again, improvements were made in the machinery and appliances of the soap-works,

amongst which may be noticed the substitution of cast-iron frames for the old-fashioned wooden ones, from which many a ton of soap leaked out before solidification took place; the steam-pump superseded the ordinary ladle for fitted soaps; the steam-crutch, in some works, supplanted the wooden or iron hand-worked implement, and (in America more especially) many mechanical contrivances have been introduced for diminishing labour and hastening the operations of manufacture. To these may be added the long series of patented processes having for their object the cheapening of the manufacture by the introduction of certain substances which, without injuring the soap, enable it to be sold at a lower price to the consumer. The various processes will be fully described when treating of the manufacture of hard soaps.

CHAPTER I.

SAPONIFICATION EXPLAINED.

Chevreul's Theory.—Liebig's Researches on Saponification.

THE combination of fatty matters with an alkali—as soda and potash for example—by the aid of water and heat, is the result of *chemical action.* It is not a mere combining of the substances in the ordinary sense, for we find, after their perfect union has been effected, that the constituents of tallow, for instance (*stearine, palmitine,* and *oleine**), have undergone a remarkable change—each of these substances has acquired the properties of an acid. This important discovery was made by Chevreul, and when properly understood the practice of soap-making becomes not only more certain in its results, but infinitely more economical.

Chevreul's Theory.—Chevreul discovered that when soap was decomposed by an acid, the fatty matter which thus became *separated* or set free, possessed properties entirely different from the original substance. When melted, it reddened litmus paper; it was freely soluble in warm alcohol, and was capable of forming *salts,* like ordinary acids. When a solution of carbonate of soda was added to the separated and saponified matter, soap was again formed, while a third substance, possessing a very sweet taste, remained in the "mother liquor," which was found to be *glycerine.* The gifted chemist thus proved that soap made from tallow was in reality a compound of *stearate* and *palmitate of soda,* and that glycerine was set free during the process of saponification, which substance, being soluble, remained in the waste or spent leys, and eventu-

* The liquid constituent of tallow was generally termed *oleine* until more recent research proved it to be a compound of palmitine and oleine.

ally found its way into the sewer, or river, as the case might be.

The acids liberated during the process of converting fats and oils into soap are called "fatty acids," those obtained from tallow being chiefly stearic and palmitic acids. Olive-oil and other soft fats yield on saponification oleic acid. Palm-oil yields a mixture of palmitic and oleic acids; and cocoa-nut oil furnishes palmitic, oleic, and lauro-stearic acids.

Soap, then, is a compound of fatty acids combined with alkali and water. Other substances, however, besides oils and fats are employed in soap-making; for example, resin, a compound of several vegetable acids, is used, with tallow, to form yellow soap. *Metallic soaps*, as they are called, are produced by boiling oxides of metals with oils or other fatty matters. Diachylon-plaster, which is formed by boiling litharge (oxide of lead) with olive-oil and water, is an insoluble soap composed of oleate and margarate of lead. The glycerine formed during the process remains with the water.

Soaps are divided into two principal classes, namely HARD and SOFT SOAPS. The former are produced by combining soda and water with fatty matters, and the latter are made with potash combined with horse-oil, fish, and other inferior oils, and hence these are sometimes distinguished as *soda soaps* and *potash soaps*.

Hard soaps are of various kinds, the most important being Castile Soap, White Curd, Mottled, Yellow, and Transparent Soap. These soaps are combinations of tallow, palm-oil, cocoa-nut oil, olive oil or other fatty substances with caustic soda—that is, soda deprived of its carbonic acid by boiling with fresh lime and water.

When tallow is boiled for a considerable time in a solution of caustic soda (or *ley*, as the solution is called) the fatty matters, stearine and palmitine, assume a granular or curd-like appearance, entirely losing their greasy and oily character; and if a small portion be pressed between the folds of a piece of paper it will not produce a greasy

stain. This is proof that the conversion of the fatty substances into stearate and palmitate of soda is complete—that the mass is *saponified*, in fact. If the boiling has been sufficient, and an excess of caustic alkali remains in the ley, this will subside, and the soap, after being allowed to repose for a short time, will appear on the surface. If now a small portion be treated with warm alcohol, it will readily and entirely dissolve, forming a transparent solution of soap. After expelling the alcohol by evaporation, the transparent soap will remain, which on cooling will assume considerable hardness.

In saponifying the various fatty matters employed at the present time in soap manufacture, and which differ greatly in their composition, much care is exercised as to the strength of alkaline ley used in the first and subsequent operations of boiling. If the ley be too strong, its superior density will retard its free diffusion through the mass of fatty matter. It is commonly the practice, therefore, with tallow soaps, to apply caustic ley of a moderate strength at first, and when this has become exhausted or "spent," as it is termed, it is pumped out of the copper or pan, and a fresh charge of ley of superior strength given, and the boiling continued until the grease or fat is "killed" or neutralised by the alkali. During the boiling glycerine is liberated, and this substance, being soluble in water, subsides with the ley. Until recently, the exhausted leys were allowed to flow away as a waste product; at the present time, however, the glycerine is usually recovered by one or other of the various processes fully described in Chapter XXVI.

It is well known that caustic ley acts differently upon the various fatty bodies with which it comes in contact. For example, a weak ley will act upon tallow until its alkali becomes exhausted, or nearly so; whereas a ley of equal strength will scarcely, if at all, saponify cocoa-nut oil. When, however, cocoa-nut oil is blended with other fatty substances, it will readily become acted upon by weak leys. Again, resin, although it is readily converted

into soap by treatment with alkali, will not form a hard soap unless combined with a certain proportion of tallow, which, during the process of saponification, exerts a powerful influence upon its constituents, probably by chemical action not yet fully understood.

Liebig's Researches on Saponification.—Justus Liebig —to whose original mind we are indebted for so many valuable discoveries in organic chemistry—made some important researches on the saponification of fatty bodies, and his views should be well understood by the soap-maker who recognises the value of scientific knowledge in the pursuit of his interesting art.

"Potassa and soda soaps," says Liebig, "are readily soluble in hot water and alcohol. The addition of a quantity of water to the aqueous solution produces precipitation, the neutral salts of stearic and margaric acid decomposing into free alkali, which remains in solution, and stearate and margarate of the alkali (potash or soda), which precipitates in the form of pearly crystalline scales. Potassa soaps are more soluble in water than those containing soda. Stearate of soda may be considered as the type of hard soaps, and when in contact with ten times as much water it undergoes no striking change. Stearate of potassa forms a thick paste with the same quantity of water. Oleate of soda is soluble in ten parts of water, while oleate of potassa dissolves in four parts of water, forming a gelatinous mass with two parts, and possesses such a strong affinity for water that 100 parts absorb 162 parts in a moist atmosphere. Margaric acid acts like stearic acid. From this it follows that soaps are soft in proportion to the oleates, and hard in proportion to the stearates and margarates, they contain. Soda soap exhibits a peculiar behaviour with common salt; it loses the power of being penetrated by ley or dissolving in a solution of salt of a certain strength, and this remarkable action is an important condition in its manufacture, on which depends the separation of all free alkali and oxide of glyceryl (glycerine), its percentage of water, and its marketable condition.

"If a piece of common hard soap be cut into pieces and then put into a saturated solution of salt, at the ordinary temperature, it floats on the surface without becoming moistened, and if heated to boiling, it separates into gelatinous flocculæ, which collect on the surface, and upon cooling unite into a solid mass, from which the solution flows off like water from grease. If the flocculæ be taken out of the fluid, they congeal on cooling into an opaque mass, which may be pressed between the fingers into fine laminæ without adhering to them. If the solution of salt be not quite saturated, the soap takes up a certain quantity of the water, and the flocculæ separate through the fluid in boiling. But even when the water contains $\frac{1}{400}$th of common salt, boiling produces no solution.

"If the soap be boiled in a dilute and alkaline solution of salt, and allowed to cool, it again collects on the fluid in a more or less solid state, depending on the greater or less concentration of the solution—that is, on the quantity of water taken up by the soap. By boiling the dilute solution with soap for a considerable time, the watery flocculæ swell up, and the mixture assumes a foaming appearance; but they still are undissolved, for the solution separates from them. The flocculæ, however, have become soft and pasty, even when cold, and their clamminess is due more or less to the quantity of water they have taken up. By continued boiling this character again changes, and in proportion as the evaporation of water renders the solution more concentrated, the latter again extracts water from the flocculæ, the liquid continues to foam, but the bubbles are larger. At length a point is reached when the solution becomes saturated; but before this, large iridescent bubbles are observed to form, and in a short time all the froth disappears, the liquid continues to boil without foam, all the soap collects in a translucent mass on the surface, and the solution and soap cease to attract water from each other. If the plastic soap be now removed and cooled while the solution is pressed out, it will have become so solid as scarcely to receive an impression from the finger. In this condition it is called *grain soap*.

"The addition of salt, or a solution thereof, to a concentrated alkaline solution of soap in water, precipitates the soap in gelatinous flocculæ, and the mixture behaves precisely like solid soap boiled with a dilute solution of salt. Carbonated and caustic potassa act exactly like salt, by separating soap from the alkaline fluid (ley) in which it is absolutely insoluble."

These observations, so carefully made and clearly explained, cannot fail to be of the greatest value to the manufacturer of a commercial article so important as soap, and which, at the present day, is made from such a great variety of fatty materials, each requiring a different treatment for its skilful and economical conversion into soap. Continuing his observations, Liebig says, "The application of the above to the manufacture of soap is evident. The fat is kept boiling in an alkaline ley until all pasty matters disappear, but the ley should have only a certain strength, so that the soap may be perfectly dissolved in it. Thus tallow may be boiled for days in a caustic potassa ley of the specific gravity of 1·25° without saponifying. If the ley be stronger, a partial saponification takes place, but, being soluble in the fluid, it floats upon the surface as a solid mass. By the gradual addition of water and continued boilings, at a certain point the mass becomes thick and clammy, and with more water a kind of emulsion is formed, which continued heating renders perfectly clear and transparent if a sufficient quantity of alkali be present. In this state it may be drawn into long threads, which on cooling either remain transparent, or are more milky and gelatinous. As long as the hot mass, when it drops from a spatula, exhibits cloudiness or opalescence, the boiling is continued or fresh alkali added. When excess of alkali is present the cloudiness arises from imperfect saponification or insufficiency of water: the former is seen by dissolving a little in pure water, which becomes perfectly clear when the whole is saponified. If the ley contains lime the mixture is also clouded, but the addition of carbonated alkali instantly clarifies it.

"In order to separate the soap from water, free alkali,

and oxide of glyceryl, a large quantity of salt is gradually added to the boiling mass, on each addition waiting until it is dissolved. The first addition increases the consistency of the mass, while each successive portion renders it more fluid, till it loses its threading character, and drops from the spatula in short, thick lumps. As soon as the congelation is complete—that is, when the gelatinous floccula separate from a clear watery liquid—the fire is extinguished, the soap allowed to collect on the surface, and cooled either on the liquid or ladled out and allowed to solidify. In the former case it is impure from water, free alkalies, or other impurities of the ley, and is therefore unfit for the market, although sufficiently good for domestic use. As in other chemical operations a precipitate is purified by boiling it in a fluid in which it is not soluble, so is soap purified by a solution of salt rendered alkaline.

"When the saponified fluid is made with potassa, the salt (chloride of sodium) operates in a two-fold manner: it dissolves in the pasty liquid and decomposes, forming on the one hand chloride of potassium, and on the other soda soap. When potash ley is employed in soap-making, the first salting requires more than twice the quantity of salt. In the preparation of potash soaps, a concentrated potassa ley is employed for separating the soap. The saponification of fats is not completed by the first treatment with leys, and the subsequent addition of fresh leys, besides purifying, also renders saponification more perfect."

It must be obvious, on perusing the above remarks of the great German chemist, that the first duty of the soap-maker is to make himself thoroughly conversant with the principles of saponification, and not to rely solely upon his own observation. The soap-boiler, be he ever so skilful and observant—and there are many such—should avail himself of such important information as is conveyed in the above lucid and practical observations.

It will be seen that the combination of alkali with fatty matter is not by any means a rapid process, but is the result of slow and gradual chemical action, during which

considerable heat is generated over and above the actual temperature of the materials when placed in contact. Although saponification is hastened by the process of boiling, it is not advisable to apply vigorous boiling in the earlier stages of the operation. On the contrary, it is found better in practice to allow the boiling to be gentle at first, and to increase its rapidity toward the close of the operation, or when the materials have absorbed their full percentage of alkali.

Although it is practically impossible to make soap without liberating glycerine generally to the extent of 5 per cent., this soluble substance may be recovered, as a valuable by-product, by either of the processes hereafter described. The proper strength of leys, their gradual combination with the various fatty bodies with which they come in contact, and the slow and gentle augmentation of the boiling operation while saponification is progressing, are important considerations, upon which too much care cannot be bestowed. Indeed, it is gratifying to know that of late years some of our leading soap-makers have devoted much attention to alkalimetry, and the treatment of various fats and oils with alkaline leys of appropriate strength, according to the nature of the fatty matter to be used. The examination, by analysis, of samples from various boils of soap enables the manufacturer not only to regulate his mode of working, but also to determine the intrinsic value, so to speak, of his productions.

In making what are called "fitted soaps," the ingredients are boiled into a thin liquid mass, or emulsion, during the first operation, after which a second dose of ley, as also a considerable quantity of common salt, are introduced into the pan for the purpose of "cutting the pan," as it is termed, by which the soap separates from the ley and salt, and rises to the surface, while most of the impurities and foreign matters subside with the ley. If the materials are not sufficiently saponified and purified, the ley is pumped out and fresh ley introduced, with further boiling, and the mass is again "cut," or separated, by the addition of weaker ley and salt, the operation

being repeated if necessary. The application of common salt not only promotes the separation of the saponified or semi-saponified matters from existing impurities and the exhausted alkaline ley, but it also, by its density, facilitates their subsidence. Moreover, the presence of salt in the ley doubtless enables it to acquire a higher temperature during the subsequent boilings, and thus hastens the evaporation of water from the saponified materials.

CHAPTER II.

THE SOAP FACTORY—ITS APPARATUS AND APPLIANCES.

The Soap-Pans. — Morfit's Steam Series. — Ley Tanks. — Frames. — Wooden Frames. — Iron Frames. — Crutches. — Steam Crutch. — Various other Implements. — Barring Apparatus.

WHEN we consider the magnitude of the operations connected with the art of soap-making, and the large quantities of soap annually produced by our numerous manufacturers, we cannot help reflecting upon the comparative simplicity of the apparatus and utensils employed at an ordinary soap-works. A series of iron pans or coppers, set in brickwork, with firegrate below, or steam-pipes passing into the interior of each pan; a series of wooden or cast-iron frames to receive the finished soap; sundry pails or buckets, shovels and trowels; iron pumps and "shoots" for removing waste or spent leys; a few hydrometers and thermometers; tanks for preparing caustic alkali; wheelbarrows and trollies for conveying materials; "swimmers" and ladles of various kinds; "crutches" and stirrers; a wooden machine for cutting soap into bars, with the usual firing tools, form the chief requirements of an ordinary soapery.

In some of the more extensive works, however, many mechanical improvements have been introduced, which will be referred to in the following pages. For the present we will endeavour to demonstrate the requirements of a soap factory of moderate dimensions, in which advantage has been taken of some useful labour-saving appliances, as also of the application of steam, in place of fire, in the operations of soap-boiling.

The Soap-Pans were generally made of cast-iron, with a flange round the upper surface. These pans are concave at the bottom, and are fitted with steam-pipes which terminate in a perforated coil which rests on the bottom of each pan. The pans are set in brickwork, and an iron pump for removing the finished soap and leys is fixed between each pair of pans. This pump is worked by steam, and is connected to two movable arms of broad iron tubing, one of which rests in each pan. These tubes are raised or lowered by means of a chain and pulley, so that they may be allowed to dip into the soap to any required depth, or into the ley beneath it. The pump can empty the contents of one or both pans at the same time.

The pans project about three feet above the floor, which enables the soap-boiler and his assistants to manipulate them with perfect ease. Each pan is fitted with an iron lid, or with a wooden lid covered with sheet-iron. The lids are lowered or raised by a chain and pulley.

The soap-pan or copper (or as the French and Americans term it, *kettle*), is sometimes made of cast-iron, in several divisions, united together by iron cement, the lower portion, or pan proper, being of a concave form, the whole being set in brickwork, which is so constructed that the fire plays only upon the lower part of the pan, and not upon its sides. Soap-pans of large dimensions are generally made of wrought-iron plates riveted together.

The soap-pan is sometimes extended by placing what is termed a *curb* above its upper rim, which is made of stout sheet-iron, or of wood bound with iron. The object of the curb is to prevent the overflow of the soap during the more vigorous operation of boiling. Sometimes (when steam heat is employed) stout blocks of wood are placed round the flange of the pan instead of employing the curb.

Morfit's Steam Series.—The accompanying engraving (Fig. 1) represents a steam series designed by Mr. Morfit. Although not so simple as the arrangement previously described, it is an ingenious system, and might be adopted with

advantage. The three pans represented may be employed, if preferred, for boiling three different kinds of soap—namely, one for white or curd soaps, another for yellow or resin soaps, and a third for superior soaps. W is the boiler, to which the main pipe or feeder G is connected. The boiling-pans, which are of iron, are each fitted with a wooden curb A A, hooped round by iron bands. The

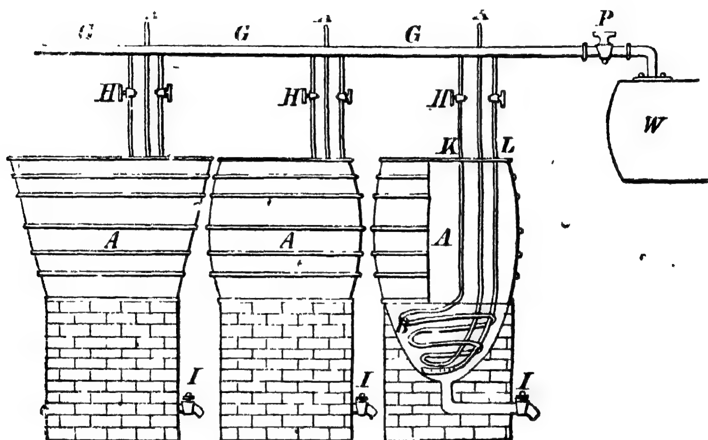


Fig. 1.

lower part of each pan B is of cast-iron Connected to the bottom of the pans is a pipe and stop-cock I, for drawing off the spent leys. H H is a downward pipe for conveying the steam to the coil, which terminates in a vertical length of piping X for the escape of waste steam. The taps H H are used for turning the steam on or off. A "blowpipe" L is connected to the main pipe G. This blowpipe terminates in a single coil perforated with a number of holes. The object of the blowpipe is to give additional heat, when necessary, and to assist in stirring up the contents of the pan. The tap P is used for regulating the pressure of steam from the boiler W.

Steam-jacket pans, especially for small operations, are very useful in a soap factory, and are admirably suited for

remelting, in the preparation of fancy soaps. Such pans are much used in dissolving silicate of soda, sulphate of soda, and other materials employed in cheapening soaps.

The Ley Tanks, containing caustic alkali of various ascertained strengths, are sometimes placed at one end of the series of soap-pans, and at a suitable height above them, so that the leys may be conveniently run off by iron shoots into each pan, by turning the tap connected to either tank. These tanks are commonly made of wrought iron plates riveted together.

Iron Frames.—The frames for casting the finished soap are now generally made of cast-iron plates, united by movable bolts and screws—the ends and sides of which fit into an iron base. These frames generally hold about 11 cwt. of soap. Fig. 2 represents an iron frame partly screwed up.

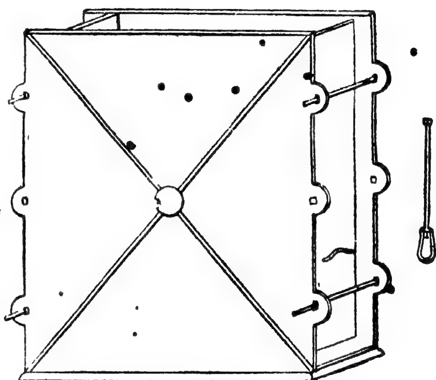


Fig. 2.

Wooden Frames, which formerly were used for all varieties of soap, are now chiefly used for mottled soaps, which are required to cool slowly in order to acquire the agreeable marbled appearance for which they are famed. These wooden frames are furnished with pegs and holes, so that they may be piled one above another, and form, as it were, one deep frame or well, capable of holding a considerable quantity of soap. Indeed, sometimes these frames are built up, through several floors, to

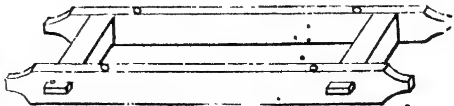


Fig. 3.

a great height, forming a receptacle for an entire boil of many tons of soap. Sometimes the frames are bound together by long iron screwed rods which pass down through them.

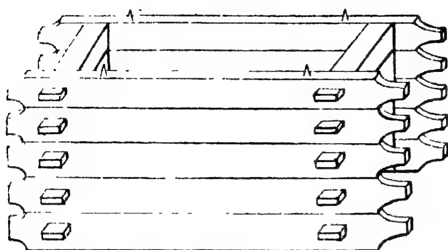
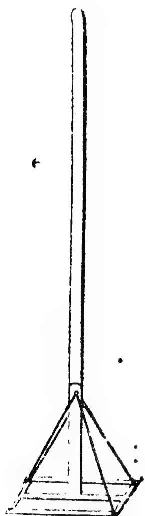
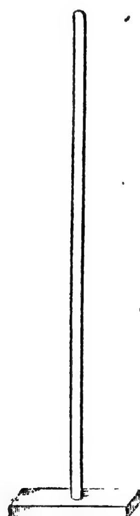

Fig. 4.

Fig. 3 is a single wooden frame, and in Fig. 4 several wooden frames are shown connected by their pegs to each other.

The interior width of soapframes corresponds to the length of a bar of soap, and the length of a frame is equal to the thickness of about twenty bars of soap.


Fig. 5.

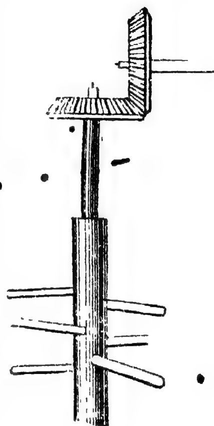

Fig. 6.

Crutches.—When it is desirable to add to true soap other substances, for the purpose of cheapening or modifying it for various special purposes, the additional matter is frequently introduced by being "crutched in," as it is termed. For this purpose certain tools called "crutches" are employed. These are made of wood or iron, or of iron with a wooden handle. Two forms of these are given in Figs. 5 and 6.

Steam Crutch.—A far more effective way of mixing other substances (as silicate of soda for example) with soap is by means of the steam crutch and crutching-pot, by aid of which a perfect incorporation of the materials is effected, without manual labour, in a few minutes, and the soap thus treated is much more uniform

than it is possible to become if hand-crutched in the frame. The arrangement for steam crutching may be thus briefly described:—

A wooden platform is erected about ten feet above the floor of the boiling room near the soap-pans; in this a small pan is set for containing the liquid materials to be added to the soap, and which receives the required charge of liquid for a frame of soap. By the side of this platform, and connected to a shaft above, is a vertical revolving spindle, furnished with several flat steel blades (Fig. 7) fixed alternately and in an angular direction. This revolving spindle or "steam crutch" is raised or lowered by means of a rope and pulley. When required for use, the crutching pot is wheeled up to and immediately beneath the crutching spindle, the wheels of the "pot" being placed in grooves or hollows in the floor. The pot having received a supply of soap, the quantity of which has been duly gauged by a notched stick, the steam crutch is lowered, and sinks into the soap, revolving with considerable rapidity.


Fig. 7.

The contents of the little pan are now allowed to flow into the pot, and soon after the required quantity has been crutched in, the revolving shaft is stopped, and the crutch raised out of the pot, which is then wheeled away to make room for a second pot, and is then drawn up close to a frame, and its contents allowed to pour out by raising an iron gate situated near its base. Fig. 8 represents the crutching pot with its gate A raised by the lever B; and at Fig. 7 is a drawing of the steam crutch, in which its several blades are shown. The bevel wheels above indicate its connection with the usual shafting.

In small works, where steam is not extensively employed, waste leys are pumped from the soap-pans by

iron hand-pumps, which are lowered into the pans by means of a chain or rope.

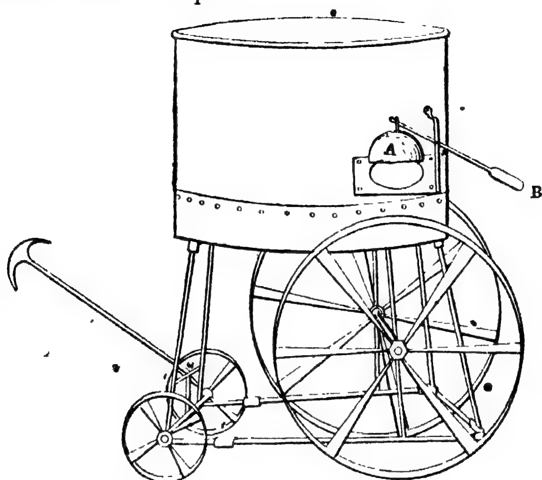


Fig. 8.

Various other Implements are employed in the soap-boiling department; these are the trowel (Fig. 10), the ladles (Figs. 11 and 12), the "swimmer" (Fig. 13), and various broad shovels and iron "shoots" (Fig. 9), the

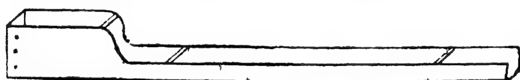


Fig. 9.

latter being used for conveying leys and soap to and from the pans. Besides these, however, wheelbarrows and



Fig. 10.

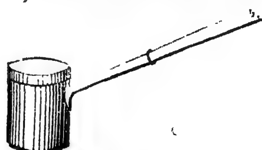


Fig. 11.

trollies are used for conveying materials, such as casks of fatty matters, resin, and other goods.

One of the most important, and at the same time most disagreeable, operations connected with a soap-works is that of making the caustic leys. This is generally conducted in a building at a convenient distance from the boiling room, and in such a situation that the lime-waste resulting from

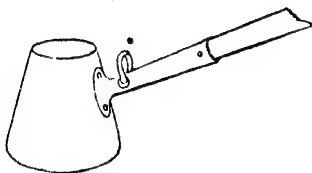


Fig. 12.

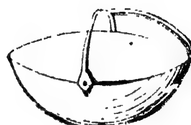


Fig. 13.

the operation can be readily removed to a part of the adjacent ground where it will be out of the way. The soda and slaked lime employed in the production of caustic soda are, with the necessary addition of water, boiled together by means of steam, and the resulting ley, after subsidence of the carbonate of lime, is pumped out or drawn off into tanks ready for use.

Barring Apparatus.—The ordinary apparatus employed for cutting soap into bars consists of a wooden machine running upon wheels (Fig. 14). A back of stout timber projects several feet above the grooved table *a*, upon which the slabs of soap are piled, and are kept in position by the upright back, *b*. Two men, provided with a length of brass or steel wire looped at each end, take their stand at the machine, and first mark the width of the bars by means of the toothed gauging stick (Fig. 15), which, being drawn

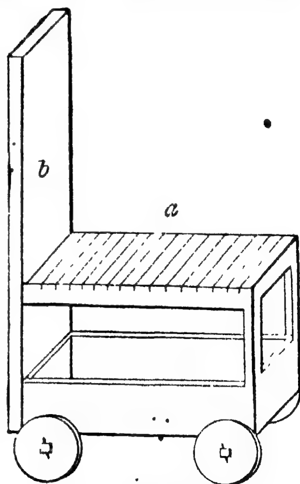


Fig. 14.

evenly downwards, marks each slab as a guide for the cutting wire. Each man now takes one end of the wire,

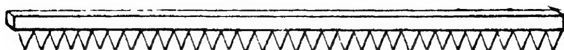


Fig. 15.

and passes a wooden handle through the loop. The wire is then placed in the notches made by the gauge, and is then steadily drawn downward until it sinks into the groove beneath. One of the men now removes his handle from the loop, and the other draws the wire through the groove and returns the end of the wire to his mate, the same operation being repeated until the entire number of slabs are cut. The bars of soap are then removed, and a fresh batch of slabs placed upon the machine. Bars of soap are usually about 14½ inches long by 2½ inches thick, and 2½ inches in width.

In some factories cutting machines are used which will cut into bars a considerable number of slabs at one time. This machine consists of strong wooden framework with wrought-iron fittings, and a series of steel wires fixed at equal distances. Although this machine is capable of cutting a great number of bars by a single movement, the wires are very liable to break, and this frequently causes delay while the broken wires are being replaced. The machine, however, is a very time-saving one when in good order.

CHAPTER III.

MATERIALS USED IN SOAP-MAKING.

The Fats and Oils.—Olive-oil.—Tallow.—Lard.—Palm-oil—Cocoa-nut Oil.—Castor-oil.—Bone-grease.—Horse-grease.—Kitchen-stuff.—Oleine or Tallow Oil.—Fish-oils.—Resin.—Recovered Grease.—The Alkalies.—Caustic Soda.—Potash.—Silicate of Soda.—China Clay.—Sulphate of Soda.

The Fats and Oils.—From the period when the principles of saponification began to be understood by soap-makers, the employment of other than the ordinary soap materials commanded attention; and, aided by the investigations of chemists, the manufacturers gradually added to their list of fatty, or saponifiable, matters, until, at the present time, any material that will form soap is worked up in some way or other.

Olive-oil, as we have shown, formed the basis of continental soaps prior to the art being introduced into England. This oil is expressed from the fruit of the olive-tree, and comes into the market in three different conditions: the finest, or *virgin salad-oil;* an inferior kind obtained by greater pressure of the berries with the aid of boiling water, and a third quality obtained by boiling the residuum with water. It is the latter variety which is more commonly employed in soap-making.

When olive-oil is lowered to the temperature of 38° Fahr. it begins to congeal, and at 20° it separates into two distinct substances, *elaine,* or *oleine,* which is fluid, and *margarine,* a solid pearly substance. Margarine is not a true chemical compound, however, but is a mixture of stearine and palmitine. The proportions are (about) 72 per cent. elaine, and 28 per cent. margarine. Olive-oil is frequently adulterated with poppy and other oils. These are distinguished by not congealing at the same temperature as olive-oil, and also by retaining

air, when shaken up, more readily than pure olive-oil. If 5 per cent. of any other oil be present, the consolidation is slower and less firm, but if 12 per cent. of foreign oil be mixed with it, this floats on the surface for several days. Oils of poppy, sesame, rapeseed, or cocoa-nut may be thus recognised when mixed with olive-oil.

Tallow is chiefly obtained from the fat of sheep and oxen, the tallow being first *rendered*, as it is technically called—that is, separated from the membranous matter with which it is associated in the form of suet. The rendering of tallow is accomplished in various ways: by first reducing the suet to small pieces, and then passing a current of steam through it by means of perforated piping, or by the method patented by the late Mr. Charles Watt, in 1836, which consists in adding to the fat, while in the steaming tub, dilute sulphuric acid, to which a little nitric acid is added, and a small quantity of bichromate of potash. When the lumps of fat are nearly dissolved, about one pound of nitric acid, diluted with one quart of water, is poured into the tub, followed, shortly after, by about two ounces of alcohol, the whole being briskly stirred in. When this process was first introduced, for the operations of the tallow-melter, it was found that candles made from the tallow, thus treated, required no *storing*, as it was termed. In those days candles were frequently stored for several months before being considered fit for lighting purposes. The object of the process was to destroy the tissues surrounding the fat, which steam alone did not accomplish.

London, or "town," tallow is generally considered the best material of its kind, but Russian, South American, and, in later years, Australian tallows enter the market in large quantities.

Fats or greases of various kinds, other than tallow, are also largely employed in soap-making.

Lard, or the fat of hogs, is extensively used, especially by the French, in the manufacture of soaps. According to Ure it is composed of 62 parts of oleine and 38 parts of stearine in 100 parts, and its fusing point is 81° Fahr.

Palm-oil, which is stated to be used more extensively

by English soap-makers than any other fatty material, is obtained from the fruit of *Elais guineaensis*, and *E. melanococca*, species of palm-trees growing on the west coast of Africa The oil as it comes into this country is of a deep orange-red colour, due to the mode of its extraction from the fruit—from which no doubt the colouring matter is derived, since the oil itself is nearly colourless. This valuable vegetable fatty matter, which it would be more correct to term butter than an oil, is composed of about 30 parts of a solid substance called *palmitine*, and 70 parts of a fluid, *elaine* or *oleine*. It is solid at ordinary temperatures, but fuses, or melts, at 117·5 Fahr. By exposure to the air it turns rancid and loses its characteristic red colour. The process of bleaching palm-oil by chromic acid will be fully described in a future chapter.

Cocoa-nut Oil is derived from the fruit of *Cocos nucifera*. Like palm-oil, it is solid at ordinary temperatures, and is a pure white, and of a buttery consistence. It is extensively used in soap-making—especially for the inferior kinds of soap, and will bear a large admixture of water, in combination with silicate of soda and other substances, and yet form a hard soap. All soaps made with even a small percentage of cocoa-nut oil impart an offensive smell to the skin after washing with it. This oil is very extensively used in the manufacture of artificial mottled soaps, but more especially in the north of England, where enormous quantities of it are consumed annually.

Castor-oil, from the seeds of *Ricinus communis* and *R. Europæa*, is also used as a soap material. It is obtained largely from the East and West Indies, and also from North America. Castor-oil is supposed to contain three fatty acids, namely, *ricin-oleic*, *margaritic*, and *elaiodic* acids. When treated with hyponitrous acid, a solid fatty mass is produced, which is called *palmine*. Although not soluble alone in alcohol it will, according to Dr. Pereira, dissolve in this spirit when mixed with other fixed oils. Castor-oil is capable of forming soap with caustic alkalies, but is always used in combination with other fatty matters for this purpose.

Among the other vegetable fixed oils used in soap-making may be mentioned the oils of hempseed, rapeseed, cotton-seed, poppy, linseed, sesamum, colza, beech-nut, etc.

Besides the ordinary fats and oils, certain fatty matters called *greases* are much used by soap-makers.

Bone-grease is supplied by bone-boilers, and forms a useful soap material for mottled soaps.

Horse-grease, although not an abundant article, is available as a soap material.

Kitchen-stuff, as prepared by the "stuff-melters," is a very useful material for mottled soaps, and is largely used by the London soap-makers for this purpose. Being the produce of kitchen waste it contains many different kinds of fatty matter, but after its separation from the more solid particles, as gristle, rind, bones, fibrin, etc., by pressure, it forms an uniform fatty mass of good consistency, and contains a considerable proportion of stearine, which renders it well suited to the manufacture of a curd soap such as the London mottled soap.

Oleine, or Tallow-oil, which has been separated from stearine by pressure, in order that the latter may be used alone for candle-making, is a useful material, in combination with stronger fats.

Fish-oils are chiefly used in the manufacture of soft, or potash soaps, in combination with tallow.

Resin, or Colophony, was first employed as a soap material in England. It is extensively used in the manufacture of yellow soaps, the pale, or yellow resin being preferred for this purpose. Yellow resin generally contains a little water, which does not exist in the darker varieties.

Recovered grease, or Yorkshire fat, is obtained from the suds and washing waters of the fulling mills. It is of a brown colour, of disagreeable odour, and of a sticky consistence. When melted, and a strong solution of *carbonate of soda* added to it, effervescence takes place, from the disengagement of carbonic acid, the grease consisting of several fatty acids, which act powerfully upon the carbonated alkali.* When neutralised, and mixed

* This grease often contains oils which cannot be saponified.

with other soaps, the recovered grease is useful in the manufacture of the cheaper kinds of Windsor and other scented soaps.

The Alkalies used in the saponification of the various fatty substances employed in soap manufacture are soda and potash, the former being used, in a caustic state, in the preparation of *hard soaps*, and the latter, also being causticised, is used for making *soft soaps*. The soda supplied to soap-makers is an impure carbonate of that alkali. As we have said, soap was formerly made from *barilla*, a crude carbonate of soda obtained by the calcination of certain plants which were found on the coasts of France, Spain, and other countries; it was also made from *kelp*, obtained by burning a great variety of seaweeds on the shores of Scotland, Ireland, Brittany and Normandy in France. When Leblanc, however, introduced his invaluable process for converting sea-salt, first into sulphate of soda by treating it with sulphuric acid, and afterwards into carbonate of soda by calcining with fine coal and chalk, the employment of barillas and kelps gradually, and eventually entirely, ceased. And now, after enjoying a long period of unbounded success, other improved processes are fast taking the place of Leblanc's process.

For a lengthened period, and indeed up to the present time, soap-makers were accustomed to purchase their alkali under the name of *soda ash*, which usually contains about 50 to 52 per cent. of soda, the exact percentage being determined by processes to be explained hereafter. Soda ash, besides other impurities, usually contains from 2 to 3 per cent. of common salt.

Caustic Soda is now supplied to soap-makers at a reasonable price, consequently they prefer purchasing this important article to making their own caustic soda, which involves not only considerable trouble and delay in its preparation, but also an accumulation of lime-waste, which is not always easy to get rid of in large cities and towns.

The author, in conjunction with Mr. J. Berger Spence, obtained a patent, in April, 1882, for making caustic soda

by the decomposition of common salt by electricity, and by this process it is expected that the cost of making this important article of commerce will be greatly reduced, even beyond the present extremely low prices.

Potash, previously rendered caustic by boiling with quicklime and water, is used in the manufacture of soft soaps. American potash is, however, chiefly used for this purpose.

Silicate of Soda, or Soluble Glass, as supplied to the trade, is in the form of a thick, viscid, translucent mass, which flows very slowly from the casks in which it is stored after the heads or bungs have been removed. It is prepared by boiling ground flints (silica) in a strong solution of caustic soda. When dissolved in hot water it forms a solution which unites with certain kinds of soap very readily, forming a cheapened compound readily marketable; and since the silicate of soda possesses considerable detergent properties, its admixture with genuine or pure soap gives an advantage to the consumer which few soap adulterants can boast. The introduction and method of preparation of this interesting article into soap is due to Mr. Sheridan, who obtained a patent for his invention as far back as 1838. Since that period, however, many other patents have been obtained for the manufacture and employment of silicate of soda, all more or less based upon Sheridan's invention. Silicate of soda (or soluble glass) is now commonly made by calcining together, in a reverberatory furnace, 9 parts of soda ash of 50 per cent. with 11 parts of clean sand or powdered quartz, for hard soaps; or equal parts of pearlash (previously dried) and sand for soft soaps, the latter mixture forming silicate of potash. After perfect combination of the alkali with the silicious matter, it is cast into moulds, and afterwards quenched with water. It is next ground in a mill, and then boiled in water containing alkali—potash or soda, as the case may be. The solution thus obtained is evaporated until it indicates 59 by Baumé's areometer, or hydrometer. In this condition it is ready for mixing with soaps, but the soluble glass is generally supplied to soap-makers in the form of a

thick, viscid mass, which they reduce with hot water to any required strength.

China clay, or Kaolin, is sometimes used as an adulterant in the manufacture of some of the cheaper soaps.

Sulphate of Soda, or Glauber's Salt, is also extensively used in combination with soaps of the cheaper kind, the mixture producing a soap of considerable hardness, while reducing its percentage of fatty material.

CHAPTER IV.

CAUSTIC LEYS.

The Ley Tanks.—Method of Preparing the Leys.

The Ley Tanks are large vessels made of wrought-iron plates riveted together; in some factories they are constructed of brickwork lined with cement. Dussauce recommends large tun lined with sheet lead, with a perforated false bottom, which he believes would be the most durable apparatus for this purpose. A cock should be fitted near the bottom of each tun, and through it the clear ley, collecting in the lower part of the vessel between the diaphragm and the bottom, can be drawn off into vessels placed beneath. Near the vat should be a pump with its spout arranged for a supply of water.

The arrangement of ley tanks in a Marseilles soapworks is as follows:—

No. 1 is called the *fresh* vat, into which the fresh alkali and lime are introduced; No. 2 is termed the *avançaire*, it being one step in advance; No. 3 is the small *avançaire*, being two steps in advance, and therefore containing *weaker* liquor, and No. 4 is called the *water* vat, because it receives the water directly. Into No. 3 the moderately exhausted or spent leys are thrown. From No 3. the ley is pumped into No. 2 to be strengthened, and in like manner from No. 2 to No. 1. Upon the lime paste in No. 4, which has been taken from No. 3, water is poured; the ley thus obtained is poured upon the lime paste of No. 3, which has been removed from No. 2. No. 3 is twice lixiviated, and No. 2 once. The receiver under No. 1 has four compartments, into No. 1 the third ley, and into No. 4 the fourth ley, which is so weak as to be

used for lixiviation instead of water. The lime vat No. 4, when exhausted, is emptied out of the window near which it stands, in which case the water is poured upon the contents of No. 3, and the weakest ley upon No. 2. No. 1 is now *avançaire* to No. 4, because this has become in its turn the *fresh* vat, into which the fresh soda and quicklime are put. The ley discharged from No. 3 comes in this case upon No. 2, and after being run through it, is thrown upon No. 1.

In some large factories the ley tanks are placed in a building apart from the soapery, and from thence the ley is pumped into tanks situated near the soap-pans, a very cleanly and convenient arrangement.

Method of Preparing the Leys.—This operation is thus directed by Messrs. Charles Tennant and Co., the extensive alkali manufacturers of St. Rollox, Glasgow: "A layer of fresh burnt lime, say five measures of 112 lbs. each, is to be laid equally over the bottom of the vat, and a few gallons of water to be thrown upon the lime, until it begins to slake or fall. This layer is then to be covered immediately with 6 cwt. of soda ash, the next layer with four measures of lime slaked as before, the fourth layer with the same quantity of soda ash, the fifth layer with lime as before, and the last layer with the same quantity of alkali.

"After standing two hours, the vat is to be stanched by filling it with water or weak ley of a former vat; this is to be done gradually. After standing about fifteen or sixteen hours, the plug is to be gently loosened, so as to allow the ley to run off or trickle clear and caustic after infiltration through the beds of lime. This is called the *first runnings.* As soon as the ley ceases to run, the plug is to be tightened, and the vat again filled with water, and after standing a sufficient time, to be run down as before. This is the *second runnings*, and worked together with the first runnings in the soap-pan is an excellent ley, and works freer and better than if used separately. After the vat is run dry, it is to be turned over into another vat, covered with water, and again run down. This ley is very weak,

and is seldom worked in the soap-pan, being used instead of water, to stanch or fill up the strong or first set vats. As soda ash is not all equally soluble, it is sometimes necessary to turn the contents of the vat over a second time in order to obtain all the free alkali; but experience and care are the only sure guides. The receivers for the ley are generally much smaller vats, but it is preferable to have them of the same size, it being at all times desirable to have a sufficient supply of strong caustic ley.

"Should the ley in the course of the process of boiling the soap 'close,' as it is termed, with the materials, and not separate, a small quantity of common salt thrown with care into the boiling soap will effect a separation; but this is always to be avoided if possible. The ley may be taken out of the vat with a pump or syphon. A third running may be taken from the first vat to stanch with."

In order to ascertain whether the soda has been properly and fully causticised, a few drops of hydrochloric acid (muriatic acid) are added to a small quantity of the ley, and if effervescence takes place it is a sure indication that uncausticised carbonate of soda is present. In this case the ley must be returned to the lime again and again, if necessary, until it is perfectly caustic. Boiling the lime and soda ash is a method frequently, if not generally, adopted, and indeed there is no doubt that it is a surer method of rendering alkalies caustic than by a cold process.

A simple method of ascertaining if there be any carbonate of soda remaining in the ley is to pour a little of the ley into clear lime-water, when if the mixture assumes a milky appearance (from the formation of carbonate of lime) it is proof that uncausticised carbonate of soda is present.

In making caustic soda by steam boiling, fifty pounds of fresh slaked lime are required for each one hundred pounds of soda, and about ten to twelve parts of water to each part of soda. It is usual to slake the lime with hot water, and when the soda and lime with the water have been put into the tank or vat, the steam is turned on and

the mixture allowed to boil for several hours. The agitation produced by the boiling greatly aids the rapidity of the causticising process by keeping the soda and lime in close contact with each other. When the boiling has been sufficient, which is ascertained from time to time by the tests before referred to, the steam is turned off, and the contents of the vat allowed to repose, so that the carbonate of lime which is formed may subside. The ley is then drawn off and the lime washed several times with fresh water, the last runnings being used instead of water in future operations.

Caustic potash, for employment in the manufacture of soft soaps, is prepared in the same way as caustic soda, except that eighty parts of lime to each hundred of potash must be used.

CHAPTER V.

MANUFACTURE OF HARD SOAPS.

Castile or Olive-oil Soap.—Pure Olive-oil Soap.—Marseilles Soap.—French Marbled Soap.—Notes on Mottling.—French Formulæ for Soaps.—Composition of Pure Olive-oil Soap.—London mottled Soap.—White Curd Soap.

Castile or Olive-oil Soap is considered the type of all hard soaps, and when made from pure materials is white, emollient (from *emollier*, to soften), and is almost entirely free from odour. It is unquestionably the best known soap. The commercial article, which is also called *Marseilles soap*, from its manufacture in France having been first practised in that city, has a pleasing mottled or marbled appearance with red and grey veins permeating its substance throughout, and which are due to certain impurities in the alkali, or produced artificially by the introduction of a little sulphate of iron (green copperas) in the process of manufacture, which becomes decomposed and converted into red oxide (peroxide) of iron. As formerly made, this soap was exceedingly hard and brittle, but the introduction of other ingredients, as the oils of hempseed, linseed, and poppy, for example, render the soap less disagreeably hard, while at the same time reducing the cost of manufacture.

Pure Olive-oil Soap, or White Castile Soap, is used in pharmacy in the preparation of liniments, plasters and cerates, and also in pills. It is made from pure olive oil and caustic soda free from coloured impurities.

Marseilles Soap.—In the manufacture of Marseilles soap for commercial purposes, great care is exercised as to the strength of the leys, and also the proportions to be applied to a given quantity of olive oil. After a series of

careful experiments, made at Marseilles, it was found that the following were the proper proportions of caustic soda and oil for making this kind of soap. Each 100 lbs. of olive oil require fifty-four pounds of caustic soda ley of 36° Baumé for perfect saponification, and this amount of ley represents about 15·50 of solid caustic soda—the utmost amount that must be applied to each 100 lbs. of the oil used. Since this oil, however, varies in the proportion of solid matter (margarine) which it contains, the strength of the ley employed in the first operation of boiling must be regulated accordingly. For a thin oil (or one containing a low percentage of solid matter) the ley is reduced by water until a Baumé's hydrometer floating in it marks 10° to 11° (degrees). For an oil containing a much larger percentage of solid matter (as lard oil, lard, or other solid fat) the strength of ley should be about 8° or 9° B.

First operation.—The requisite quantity of ley (in the proportions above given) is to be first run into the pan, filling it to the extent of about one-third of its capacity Heat is then applied by fire or steam, as the case may be, and when the liquor comes to a boil, 1,600 lbs. of oil are added at one time with constant stirring. In a very short time a thick mass of a pasty consistence is formed by the reaction of the hot caustic alkali upon the oil. If from miscalculation, or other circumstance, an excess of oil has been added, this excess will show itself upon the surface, when an additional quantity of ley must be at once applied. On the other hand, if, instead of forming into a thickish paste the mixture is very thin, this indicates an excess of ley, and more oil must be added by degrees. This addition will, of course, somewhat cool the mixture, but the temperature soon rises again, and the mass again boils with considerable frothing. The boiling must be kept up for eighteen or twenty hours.

During the boiling, considerable evaporation takes place, whereby the ley becomes stronger; it is therefore necessary, when the pasty condition becomes thick, to add weak ley from time to time, since the paste is not soluble in strong

ley. Previous to the addition of weak leys, however, the "spent," or exhausted, leys are pumped or drawn off. The addition of fresh leys is kept up until the whole of the fatty matter is *killed*, as it is termed (that is, neutralised), or whenever it is found that the ley has lost its causticity, which is ascertained by dipping the tip of the finger in the ley and applying it to the tongue. Every addition of fresh ley is accompanied by constant stirring. After four or five changes of ley, with continued boiling and stirring, the mass becomes of an uniform soapy consistence, and a small portion pressed between the fingers becomes immediately hard and flaky.

Frequently the alkali from which the leys are made contains common salt, sulphate of soda, and other impurities, which have the effect of retarding the process of saponification by keeping the alkali and fatty matters in a more or less separated state, whereas they require to be intimately associated to effect a perfect chemical union. When it is found, therefore, that the process is progressing slowly from this cause, it is customary to throw into the pan a quantity of soap scraps to aid the operation.

When the soap-pans are heated by fire, it is necessary to use every precaution to prevent the burning of the soap at the sides of the pan. Should this occur, however, the fire must be slackened, and a small quantity of strong ley added, with brisk stirring, which will partially separate the pasty mass from the ley, bringing the latter in contact with the metal of the pan, and thus prevent the burning of the saponifying matter.

Second operation.—The oil being now completely neutralised with alkali, the combination in its present state also contains a large quantity of water in the shape of exhausted or spent ley. To remove this, many substances may be employed, but common salt, which answers the purpose admirably, is from its cheapness generally employed. The process of separation, which is generally termed "cutting the pan," is effected by throwing into the pan a concentrated solution of common salt, or a few shovelfuls of the same, each portion being

allowed to dissolve before the next is added. For conveying the salt, the truck shown in Fig. 16 is a very convenient vehicle. When sufficient salt has been thrown in, the soap separates from the leys (which also hold glycerine in solution) and coagulates in flakes or granular clots. The soap-boiler, by freely using his shovel—by repeatedly dipping it into the boiling mass and observing its condition—can tell in a moment when enough salt has been added.

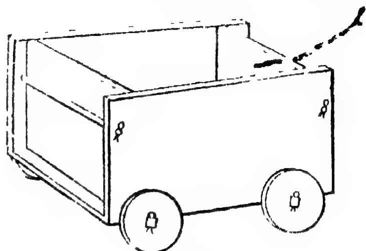


Fig. 16.

At this period the ley runs clear off the shovel or trowel, leaving the soap in separated lumps upon its surface. By continued boiling the clots assume a granular or grain-like appearance, in which condition the soap is said to be "boiled to a curd." If the boiling be continued too long after this stage, it will, by making the salted leys too concentrated, render the curd so stiff that the vapours arising from the boiling of the liquor beneath will with difficulty make their escape through the mass.

When the soap has assumed the form of grains or curds, it is known that all the superabundant water—that is, its *uncombined water*—is separated from it, and at this stage the fire is drawn or the steam turned off, as the case may be, and the pan is allowed to repose for a few hours to enable the leys to deposit. When sufficient time has been allowed for this the leys are drawn off by means of the cock situated at the lower part of the pan.

Third operation.—This is termed *finishing the soap*, by which process it becomes cleansed from saline or other impurities, which are still loosely attached, or mechanically mixed, with it and, at the same time, any portions of the fatty ingredients which may not have been thoroughly saponified, undergo perfect conversion into soap. This important operation is effected by means of a ley of such strength that it cannot dissolve the made

soap. It may be here mentioned that although soap is soluble in very weak leys, it is absolutely insoluble in strong solutions of caustic alkali. All the spent leys having been drawn off the soap, it is now gently boiled with a ley of the strength marking 18° or 20° B., to which 8 or 10 per cent. of salt is added. The quantity of this saline ley must be just sufficient to coagulate or *close* the soap, and to prevent it from adhering to the sides of the pan. While the boiling gently proceeds the soap is constantly stirred. The ley is now allowed to subside, when it is drawn off as before and fresh ley added, until, after again boiling, the leys retain their causticity—when saponification is known to be complete. At this period the boiling becomes more violent and frothy, and the soap-boiler keeps the pan from boiling over by constantly using his shovel, with which he scoops up the soap and throws it over the boiling mass.

As soon as the soap yields an odour resembling violets, and is scaly when pressed between the fingers without adhering to them, the finishing process is complete. The time occupied in this operation is from eight to ten hours in winter, and from ten to fifteen hours in summer: the length of time, however, depends greatly upon the quantity of material operated upon. When the operation is complete the fire is withdrawn, and the soap is allowed to rest for a few hours, after which the ley is again drawn off. The finished soap is white and firm, and contains from 16 to 25 per cent. of water. When the leys are impure, containing salts of iron and sulphur, it assumes a dark shade owing to particles of metallic soap permeating the mass. When this is the case, it must be again treated with weak ley, and very gently heated, when the dark-coloured soap, which is called *niger* or *nigre,* being more dense than the fine soap, and not soluble in weak ley, subsides. To facilitate this the cover of the pan is lowered, and the soap again suffered to repose, when the white soap, which forms the upper stratum, may be ladled into the frames.

The fourth operation, which is termed *mottling,* or

marbling, is the result of certain reactions which occur between the impurities of the ley (chiefly iron, sulphur, and alumina) and the saponaceous matter. When these impurities exist in considerable quantity, they give a slate-coloured tint to the soap. By examination it has been found that the fatty acids of the soap exchange bases with the saline impurities, an insoluble dark-coloured *alumino-ferruginous soap* being formed, which is diffused throughout the mass, with, also, black sulphuret of iron. These being held in suspension by the thick soapy mass form bluish veins in the white ground, thus giving the soap a marbled appearance. By exposure to the air, however, the iron salts become oxidised, and acquire a reddish hue from the formation of peroxide of iron. When the alkali, from which the leys have been made, contains a large quantity of iron and sulphur impurities, the soap becomes mottled without any artificial means. This being seldom the case with the alkali manufactured at the present day (excepting the black ash) the desired effect is produced by adding to the soap, after it is finished or clarified, and without separating it from the *niger* or *nigre*, four ounces of green copperas (sulphate of iron) for each 100 lbs. of oil in the soap. The iron salt is first dissolved in weak ley, which is added to render the paste thinnish, and the mixture must be cooled gradually, so that the coloured soap may become thoroughly diffused through the mass. Too much ley must on no account be added, otherwise the darker and heavier soap will sink to the bottom. Again, the cooling of the soap must not be too rapid or the coloured veins will close too much, and thus spoil the "strike" of the soap.

The soap is allowed to remain in the pan to cool a little, after which it is ladled into the frames. In France ladles with perforated bottoms are employed, so that any ley that may remain mechanically mixed with the soap may run off. After each frame is filled the soap is well crutched to make it homogeneous, and, if it be desired to add water, the requisite quantity is well crutched in while the soap is still hot. The frames are sometimes

covered with sacks in cold weather, so that the soap may cool slowly, upon which much of the beauty of the "strike" or mottle depends.

It has been ascertained that three pounds of olive-oil will yield five pounds of marbled Marseilles soap, whereas the same amount of oil will only produce four pounds four ounces of white soap, which proves that the former retains more water in its composition than the latter.

French Marbled Soap.—Dussauce, in his admirable "Treatise on the Manufacture of Soap," gives an elaborate description of the manufacture of marbled soaps, as conducted in France, from which we give the following extracts:—

"Besides olive-oil, the earth-nut, sesame, linseed, coleseed, and black garden poppy-oils, greases, tallows, etc., are also used in the fabrication of marbled soaps; but the soap resulting from these different combinations of oily and fatty matters, while being of good quality, cannot be compared to those obtained by the direct saponification of olive-oil. The latter are always denser, firmer, and finer.

"However, we may remark that the mixture of olive-oils with other oils containing less stearine, gives, if not the best, at least the finest kinds of marbled soap. They are also more unctuous, and their cut is softer and smoother, as they contain less stearate of soda than those prepared from olive-oil,—they are more detersive and more advantageous for use.

"The sodas employed for these soaps are of two kinds; one, called *soft soda*, is the most alkaline; the other, called *salted soda*, is composed of soft soda and common salt. Well-prepared soft soda ought to be free from common salt; it is employed to produce the *pasting* in the first operation. The salted sodas are a mixture of soft soda and salt. The proportions of salt are from 30 to 40 per cent. of the weight of soda. Their alkalimetric degree is from 18 to 22 per cent. of pure alkali.

"In certain circumstances salted soda can be substituted by common salt; nevertheless, it ought to be remarked

that an excess of salt is injurious to the marbling of the soap, and salted soda must be used whenever it is possible to obtain it.

"Soda ash is not so suitable for the fabrication of marbled soaps as crude soda. Being entirely deprived of colouring matter and of sulphurets, when it enters in too large a proportion into the preparation of the lyes, it lessens the beauty and intensity of the marbling.

"The fabrication of marbled soaps requires several distinct operations, which may be thus summed up:— 1. Preparation of the lyes. 2. Pasting, or saponification of the oils and fatty substances. 3. Separation of the saponified paste from the weak lyes it contains. 4. *Coction* (boiling). 5. Mottling or marbling."

In preparing the ley for the first operation the following proportions of soda and lime are given:—

Crude soft soda (black ash) at 34° to 38°	2,250 lbs.
Recently calcined lime	450 ,,

The soda (if in hard lumps) is first broken or crushed, and the lime slaked by immersion in warm water. "With warm water," says Dussauce, "the penetration of the liquid is more complete. After one or two minutes of immersion the lime is quickly taken out and spread on a hard, smooth, and dry floor; if the lime is of good quality it soon grows warm and falls into powder, this powder is then thoroughly mixed with the soda by means of large iron shovels. The mixture is conveyed to filters made of masonry or sheet iron, holding from 125 to 150 gallons, each filter being provided with a false bottom pierced with holes and supported by four little pieces of wood, which keep it about two inches from the bottom. A layer of straw is placed over the false bottom to prevent the mixture from passing through the perforations and to aid the filtration. A plug or cork is placed between the two bottoms of the vessel for the convenience of drawing off the ley. The mixture of soda and lime is now covered with water, when, after a while, it swells and becomes warm. After about twenty-four hours the ley is drawn

off, when its strength is usually from 22° to 25° B. Fresh water is then added, and, after many hours, is drawn off as before, the washing being continued so long as caustic alkali be present."

"The preparation of salted ley is in all respects similar to the preceding, except as regards its formula, which is as follows:—

Crude soft-soda ash at 33° to 38°	3,375 lbs.
" salted soda at 18° to 20°	1,025 "
Fresh lime	900 "

The *pasting* operation is thus given:—Take

Olive-oil	1,125 lbs.
Earth-nut oil..................................	900 "
Black garden poppy-oil	225 "
	2,255 "

The saponification is effected in a sheet-iron kettle holding about 1,000 gallons, into which from 125 to 150 gallons of "soft ley," at 10° or 12° B., are poured. Heat is applied, and, when boiling commences, the oils are added by degrees, with constant stirring. Soon after the oils have been added, and the boiling again started, a violent agitation takes place with considerable foaming. At this time the mixture swells up greatly, when the heat must be lowered, or the mass would inevitably boil over. After awhile the foaming ceases, and a perfectly homogeneous mass of a dull white colour is formed. The boiling is continued for four or five hours. By the ebullition the mixture of the materials becomes more and more intimate; it also acquires more consistency and strength by the evaporation of the water from the ley; then add 25 to 30 gallons of ley at 15° or 18° B., with stirring for about ten minutes. Boil a few hours, and, when the mixture has acquired a thicker consistency, add to it one pound of green vitriol (sulphate of iron), previously dissolved in a few quarts of boiling water. By this addition the paste, which was of a reddish white, assumes instantaneously a greenish colour, the intensity of which

depends upon the degree of sulphuration of the ley. To combine the sulphate of iron with the paste the mixture is well stirred for a few minutes; under the action of the soda, the iron is decomposed, forming an oxide of iron. The chemical union of this oxide with the sulphuret of sodium, which always exists in the leys of crude soda, produces the colouring principle of the marbling of the soaps.

In order to ensure an intimate combination of the fatty matters with the ley, and also to give a good consistency to the paste, from 25 to 30 gallons of soft ley at 25° B. are added gradually, with constant stirring, and the boiling continued for several hours. The pasting operation, as it is termed, generally occupies about fifteen hours, when a perfectly neutral soap is obtained.

The separation of the soap is thus conducted. In soap factories, to produce separation, they throw on the soapy mass, by small quantities at a time, limpid regenerated leys at 25° to 30° B. When these leys cannot be had, new salted leys, at 20° to 25°, can be used, or a solution of salt at 20° B. To obtain 25 gallons of salt solution at 20°, 14½ lbs. of salt are employed. When the saponification is complete, and the paste has the required consistence, it is watered with a sufficient quantity of old and salted ley at 25° to 30°. To render the action of the leys more thorough upon all the molecules of soap, a large board is placed over the kettle, on which a man, provided with a beater or crutch, stands to stir the mass continually, from bottom to top, in such a manner that the ley brought to the surface penetrates every portion of the soap. The paste now separates into clots or curds, and, if the ley runs off freely from the shovel or trowel, it is known that the separation is complete. The soap is then allowed to rest, when the ley slowly subsides. After a few hours the ley is drawn off, which consists of from 175 to 188 gallons of ley at 17° or 18° B. This ley, after being passed over an old residuum of soda exhausted by washing with water, is used in the operation of mottling.

The next operation is called *coction* (boiling), by which

the complete combination of the oils or fatty matters with the alkali is ensured. It is this operation, also, which gives hardness and consistency to the soap, increases its density, and deprives it of all disagreeable odours, besides rendering it more detergent.

The leys used in this operation are termed *salted leys*, being a mixture of soft (not caustic) soda and artificial *salted* sodas, causticised by lime, as before described; but before the application of this ley the soap is treated with 88 gallons of *cold soft ley* at 20° to 25° B., which is thoroughly well crutched in. This has the effect of separating the soap into flakes which float on the ley. After stirring for half an hour the cover is lowered to keep in the heat, and, in about four hours after, the ley is drawn off. Dussauce says: "Some manufacturers for the first service use salted leys, but, in our judgment, soft leys are to be preferred. Indeed, there is already in the paste an excess of salt, due to the leys employed for the separation, and, as too large a quantity of salt interferes with the useful action of new leys on the molecules of soap, it is proper and rational to eliminate it from the paste as much as possible. The soft leys contribute to this result. This advantage is not the only one, the leys of coction, used in considerable quantities in the separation, have set free some fatty matters imperfectly combined; then the soft leys, while purifying the paste from the excess of salt it contains, determine the incorporation of the oily or fatty substances which had not been combined before, and could not be if salted leys had been used."

The above observations are of considerable value, inasmuch as they guard the soap-maker against falling into a very common error—that of applying salt before saponification is *known* to be complete.

The first application of the salted ley is given after the ley of the last operation has been drawn off. From 100 to 115 gallons of salted ley, at 25° B., are put into the pan and heat applied, with stirring so soon as boiling commences. The boiling is to be continued until

the ley ceases to taste caustic, which is generally after seven or eight hours. A black foam or "fob" appears on the surface, which only ceases when the materials are completely saturated with alkali. The heat is now checked, the mass allowed to rest for three or four hours, after which the ley is drawn off. A second dose of 115 to 125 gallons of salted ley is now given, of a strength equal to from 25° to 30° B., and the boiling resumed and kept up for twelve to fifteen hours, with occasional stirring. About every hour, during the first eight or ten hours, about 5 gallons of ley, at 28° to 30°, are added to supply the place of the evaporated water and complete the saturation of the soap. It is usually towards the close of this boil that the operation is complete, the foam having disappeared, and the soap is now stiff, clean, and dry, and furrowed by deep channels. The ley, though coloured, is clear, and should be slightly caustic to the taste. If these conditions are not fulfilled the ley must be drawn off, after repose for two hours, and 75 gallons of salted ley at 28° or 30° B. added, with further boiling for seven or eight hours.

Mottling.—The next and last operation is termed *mottling*. The soap having rested for an hour or two, the last ley is drawn off, and a pure ley, at 12° to 15° B., is sprinkled over the surface of the soap with continual stirring, which thus becomes of a somewhat softer consistence. A weaker, pure ley, at 8° to 10° B., is then added and well stirred in, when the soap, which up to this time was in hard, granular, and curd-like lumps, becomes softer, the grains of soap being more plastic and viscid. The operation is now finished by boiling with leys at 5° or 6° B., which are gradually introduced, otherwise the weaker ley would spoil the adhesiveness of the soap. When the soap floats on the ley in large flakes of a greenish colour it is known that it is ready for the frames.

If the condition of the soap, with the above treatment, is defective, it arises from one of two causes. 1. The addition of the cold leys has cooled the soap too much; or, 2, the soap contains an excess of saline matters. In

the first case the soap must be heated gently, and when the ley is sufficiently warm, stir well until the proper consistence is obtained. In the second case, run off the leys, and add fresh pure ley at 10° to 12° B., with gentle boiling and stirring.

Before putting the marbled soap into frames, it is usual to first place a little warm ley at the bottom of each frame, to prevent the soap from adhering to it; sometimes, also, a piece of canvas is laid over the bottom of the frame with the same object. When properly boiled, the soap is in the form of hard and separate grains, the entire mass having a bluish-black colour, the intensity of which depends upon the quantity of metallic soaps present in the mass, and which are due to the salts of alumina and iron contained in the ley. These metallic soaps, during the cooling of the mass, separate from the white soap (which forms the ground or base) in irregular veins of varied colour, and thus a marbled appearance is obtained, the beauty of which depends greatly upon the skilful manipulation of the "mottler," or workman who superintends this part of the operation. It is an important point to run the soap into the frames when the proper condition for good mottling has been attained.

Notes on Mottling.—The strongest ley is first introduced, then the medium, and lastly the weakest.

The principal points to be observed in mottling are: 1. The introduction of weak leys into the paste; 2. The application of gentle heat to keep the mass in a fluid state; and, 3. Continual stirring.

The precautions to be observed are: 1. Not to add more leys than are necessary, so that the heavier metallic soaps (which are the colouring principles of the mottling) may be thoroughly disseminated through the mass of white soap, and ultimately produce the marbled veins which are characteristic of the soap. 2. The temperature of the soap must not be too high. 3. If too much weak ley has been applied, this, by thinning the mixture, will cause the heavier metallic soaps to sink into the leys, and the soap will be white instead of being marbled. 4. If the

leys be too strong, the metallic soaps will not separate properly, and the entire mass will contain less than its full proportion of water, thereby entailing a loss to the manufacturer.

All circumstances being favourable, the following characteristics will present themselves: the flakes of soap are separated from each other, and float on the ley; they are soft and bulky, of a fine green colour, and of a viscid consistence. When ready for the frames, the grains are "pliant and elastic, and have a tremulous and gelatinous appearance." The soap must not be put into the frames until it has cooled down a little, the proper temperature being between 158° and 166°.

French Formulæ for Soaps.—The following formulæ represent some of the fatty combinations used in different localities in France in the manufacture of soap:—

I.

Olive-oil	675 lbs.
Earth-nut oil	675 ,,
Lard	900 ,,
	2,250 ,,

This produces a white, odourless soap.

II.

Bleached palm-oil	1,575 lbs.
Oil of sesame	450 ,,
White tallow	225 ,,
	2,250 ,,

Produces a very hard soap, of good quality, but not so white as the above. It turns slightly yellow by keeping.

III.

Olive-oil	450 lbs.
White tallow	1,350 ,,
Earth-nut oil	450 ,,
	2,250 ,,

This is considered to form a very good soap, and superior

to that of Marseilles, but "unfortunately it has a faint smell of tallow, which restricts its use in domestic economy." (!)

IV.

Olive-oil	675 lbs.
Cocoa-nut oil	225 „
Lard	675 „
Tallow	675 „
	2,250 „

This formula makes a good white soap, but the presence of cocoa-nut oil gives the soap a disagreeable odour, although it improves its lathering properties.

The Composition of Pure Olive-oil Soap, according to Ure's analysis, is:—

Foreign.

Soda	9·0
Fatty acids (oleic and margaric)	76·5
Water and colouring matter	14·5
	100·0

English imitation.

Soda	10·5
Fatty matters	75·2
Water, with a little colouring matter	14·3
	100·0

The ordinary commercial Marseilles soap contains from 62 to 65 per cent. of fatty acids.

London Mottled Soap is generally made from melted kitchen stuff, bone grease, cheap tallow, and any inferior fatty matter that will prove serviceable. The leys are made from crude soda ash, termed *black ash,* the impurities in which give the mottled or marbled "strike," for which this variety of soap is famed. The "goods," as the fatty materials are called, are first put into the pan, when the first dose of ley, at sp. gr. 1·050, is run in, after which the fire is made up beneath the pan, and the materials brought to a steady boil. To assist the combination of the fatty substances with the ley, a workman constantly

stirs the ingredients with a long iron rake. After a while the fatty matters, which at first float on the surface of the ley, combine with it, forming a thin creamy emulsion of a perfectly uniform appearance, and from which no liquid separates on cooling. Should the mass not present these characteristics, the soap-boiler adds either water or some weaker leys than were at first employed, and the boiling is continued, with occasional stirring, until a perfect emulsion is obtained.

At this stage of the operation the compound ceases to taste alkaline—the tongue being the usual test employed by the soap-boiler—and it is thus known that the combination of the fatty matters with the caustic ley is complete. Stronger leys are now added repeatedly, the boiling being continued until the leys taste of free caustic alkali When this is the case, more oily or fatty matters are added, as also, from time to time, stronger leys. Great care is taken, in this operation, that there is no excess of alkali in the mixture when the soap-pan has become sufficiently filled with the alkaline and fatty ingredients.

The mixture is next treated with common salt, which is thrown into the pan by shovelfuls at a time, each portion being allowed to dissolve in the ley before adding the next. When sufficient salt has been added, the saponified matters separate into grains of soap combined with a definite quantity of water, but as yet not containing its full percentage of alkali. The leys, which are called "spent leys," consist of salt and glycerine in solution, and should be quite free from alkali.

The fire being withdrawn (or steam turned off), the imperfect soap is allowed to rest for a few hours, so that the ley may subside, and this is then drawn or pumped off

The second operation consists in adding weak ley, with which the soap is again boiled, until the soap (at first granular) becomes homogeneous, or "closed," as the soap-maker terms it. If the full quantity of fatty matters had not been introduced in the first operation, the soap-boiler now completes the addition of them, with also the addition

of more strong ley, until, after long boiling, the compound has acquired a strong alkaline taste. Common salt is now again added to separate the soap as before from the ley, and the boiling continued for some hours in contact with the caustic ley, so as to ensure the perfect saponification of every atom of fatty material.

Soda which contains sulphurets (as the so-called *black-ash*) is preferred for making mottled soaps, for reasons which have been already explained. Mottling is commonly practised in some London soap-works by introducing into the nearly finished soap a certain quantity of strong crude soda ley through the rose spout of a watering-can. The dense sulphuretted liquor, in passing through the pasty mass and ley, gives it a marbled appearance. Sometimes a small quantity of a solution of Prussian blue is used for this purpose.

When crude sodas, however, are used in the manufacture of mottled soap, the mottling is effected, towards the close of the operation, by a mere mechanical mixture of the dark-coloured ley with the soap. It is effected in this way: the workman breaks the paste in all directions with his rake, after which he holds it perpendicularly till it reaches the ley; when he raises it vertically with a jerk, making it act like the piston of a pump, by doing which he lifts some of the ley and spreads it over the surface of the paste. In its subsequent descent through the numerous fissures and channels of the soap, on its way to the bottom of the pan, the dark-coloured ley impregnates the soapy particles in various forms and degrees, thereby producing veins or markings which, when the soap is afterwards cooled, give it the desired marble-like appearance. This operation has also the advantage of cooling the soap in some degree, which is necessary before it is put into the frames, or the "strike," or mottling, would not be perfect, owing to the superior density of the dark particles which form the coloured veins of the soap.

When mottled soap is ready for framing, it is in the form of a thick, gelatinous mass, interspersed with leys, and in this condition it is ladled out into large pails and

put into frames, which are preferably made of wood, since this material retains the heat longer than iron frames, and by the more gradual cooling a finer marbled appearance is obtained. When mottled soap is moulded in cast-iron frames, the ends of the bars are liable (from rapidity of cooling at the sides of the frames) to have a plain whitish appearance, instead of being marbled.

White Curd Soap.—The finest quality of this soap is made from pure tallow, *rendered*, as before stated, from the suet of oxen and sheep. English, or "town tallow," as the London tallow melters call it, in contradistinction to the products imported from Russia and other foreign countries, was generally preferred until the introduction of American and Australian tallows, which, being of good quality, are equally serviceable in the manufacture of this soap. Besides tallow, however, other materials, as lard, bleached palm-oil, olive oil, or mixtures of these in varying proportions, are used in making curd soap.

To produce one ton of curd soap, from 10 to 14 cwt. of tallow or olive-oil are required. The process of saponification is the same as for mottled soap, excepting that the removal of all colouring matter and impurities of the ley must be effected by boiling the soap repeatedly with fresh leys after the removal of each previous dose of ley, or by thinning the soap with a small quantity of ley with gentle boiling, and then covering the pan and allowing the soap to repose for several hours, to allow the leys to subside. By thus washing (as we may say) the soap with ley, all the dark-coloured impurities are removed, and subside with the leys, leaving the soap clean, and, when cold, white. When finished, the curd is ladled out of the pan and put into the frames, which should be covered with canvas, or clean empty sacks, so that the soap may retain its heat, and thereby enable it to close properly.

The following is the French system of making tallow curd or grained soap: to transform 1,000 lbs. of tallow into grain or curd soap, 400 lbs. of potash have to be taken. The tallow is placed in the kettle (pan), about 400 lbs. of ley of 10° B. added, and the fire kindled. In a short time

from the commencement of the boiling, the fire is kept well up, but afterwards it should be moderated. After the usual frothing, it should be ascertained whether the fat has combined with the ley. This is known by the yellow-brown mass, which, under gradual upheaving, continues quietly to boil. What adheres to the spatula, when dipped into the mass and withdrawn, has a gelatinous, greyish-white appearance, without separation of ley. When the ley and fat are not combined, the mixture moves in the kettle to and fro without rising upward, except now and then, in isolated spots, with a booming noise. When the combination is complete, there are added, at short intervals, and in four or five portions, about 1,000 lbs. of ley at 16° to 17° B. The boiling now becomes dense and languid, and the mass appears of a yellowish-brown, and runs off the spatula in cohesive, long, translucent strings, and the soap boils to a paste. If some of the soap be dropped on glass, and the sample, while still hot, does not appear perfectly clear, ley is still wanting. A small quantity of ley should now be added, until the soap, while hot, appears perfectly clear. When this period is reached, the "cutting of the pan" begins.

The salt has here a double purpose to fulfil. It must transform the potash into a soda soap, and also separate its glycerine, sulphurous liquor, ley, and impurities. The full quantity of salt required for this purpose is not applied at once, but a repeated "salting out" should be given. After each "salting out," the under ley is separated from the soap, and the latter brought in contact with water and salt. By boiling tallow and potash, when the materials are not very pure, the "salting out" is usually performed in three operations. The ley is now removed from the soap in the usual way. The salt is either thrown into the soap in the dry state, or in solution of about 20° B. When the mass turns white, and ebullition occurs all over the pan in patches, the soap rising with considerable vigour, it is known that sufficient salt has been added. The frothing now disappears. The boiling is continued for an hour longer, and then stopped

by extinguishing the fire, so as to allow any impurities still in the mass to settle.

When the ley has been removed from the pan, 700 lbs. or 800 lbs. of water, with 70 lbs. or 80 lbs. of salt dissolved in it, are now added, and the mass again brought to a boil. After boiling up, it should be examined to see that the "cutting of the pan" has been properly effected. The boiling is then continued for some time, after which the mass is allowed to repose as before, and the saline ley again drawn off. Although the second liquor and boiling have greatly hardened the soap, yet this is not sufficient; therefore a third boiling, with 50 lbs. to 60 lbs. of salt dissolved in 700 lbs. to 800 lbs. of water, is made, by which the hardness of the soap is perfected. As soon as it boils and froths up, the soap must be again examined to ascertain if the proportions of salt and ley have been sufficient. If enough salt has not been added, froth appears on the surface of the boiling soap, and the latter burns readily. In this case more salt must be added, until it boils up in regular lumps of soap. If too much salt be present, the soap appears upon the spatula [trowel] in a separated form, the ley running off, and little gutters formed. This fault is remedied by adding a few buckets of water. If a little portion of the soap be pressed by the thumb in the palm of the hand, it hardens immediately; and if, on rubbing it, the sample retains a cohesive character, it possesses the required firmness, and is solid; if, on the other hand, it crumbles, more water must be added, and if the sample spreads or smears, a fresh ley of salt of 15° B. must be added until the proper condition is reached.

The operation of clear boiling and fitting is next pursued, to perform which one-half of the kettle is covered with wooden planks, and a man, furnished with a stirrer or beater, beats down the mass, so that it does not run over. By this operation the soap particles are drawn more closely together into globular grains. These grains sink, and on the surface of the kettle appears a white flaky froth. To prevent the falling of the mass, great

heat is now needed. The fire is briskly kept up, and the entire kettle covered with planks and cloths. The soap now boils up with considerable frothing, and to prevent it from running over, one of the planks is removed, and the foam is beaten with a long iron rod until it subsides. The kettle is again closely covered, and the boiling resumed, the prevention of overflow being again regulated as before.

The violence of the ebullition gradually diminishes, but in its stead a whistling noise is perceived in the kettle. One of the planks is removed from time to time, and the soap examined; when, if large and perfectly translucent bubbles rise up, the soap is finished, and the fire is therefore extinguished. The wooden planks are next removed to allow the soap to cool, and a few buckets of soap ley are poured into the kettle. The soap is now ready to be put into the frames, and care is taken that as little ley as possible enters the frames.

Boiling with soda ley presents this advantage, that the soap may be finished in one water. The first ley is applied at the strength of 10° to 12° B. The whole of the fat is placed in the kettle, with one-fourth of the ley requisite for saponification, and the boiling carried on as usual. After boiling up, the mixture is examined to ascertain if the proper combination has taken place, in which case further addition of ley, at 16° to 18° B., is added. The addition of this ley is continued until a sample placed on a piece of glass appears perfectly clear. The cutting of the pan follows, which removes the glycerine liberated, and the surplus water. In this case much less salt is required than when boiling with potash ley. For each 100 lbs. of fat 10 lbs. to 12 lbs. of salt are required. The salt may be applied in the dry state or in solution, as preferred. The remaining operations are conducted as before described.

Soda soaps made by this process have some advantages, principally because it is impossible to remove all the potash; besides which, they are generally very neutral and plastic.—*Dussauce.*

It was formerly the practice in England to make tallow soap with potash leys, as above described, and the soft soap thus produced was converted into hard soap by additions of salt in sufficient quantity to furnish the proper proportions of soda by the reaction of the potash with the neutral salt. The high price of potash, and a great reduction in the cost of soda, however, caused this system to be abandoned in this country.

CHAPTER VI.

MANUFACTURE OF HARD SOAPS—(continued).

Yellow or Resin Soaps.—Continental Method.—Dunn's Process.—Meinicke's Process.

Yellow or Resin Soaps.—Although resin is freely soluble in alkaline leys, it is not capable of being converted into soap proper by itself. When mixed with fatty matters in various proportions, however, it forms a series of soaps possessing high detergent power, and exceedingly emollient and agreeable in use. A well-made resin soap is no doubt the most pleasant of all soaps for washing the skin. Possessing no "body" of itself, the smallest proportion of sound tallow which it requires to make a hard soap is an equal part. It is seldom, however, that so large a proportion of resin is used in soap. The peculiar odour of resin is greatly disguised by its combination with fatty matters, and it has been stated that rancid tallow disguises the odour of resin in soap more than any other description of fat or oil, except cocoa-nut oil, we might add, which gives an odour to soap that even the most powerful perfumes overcome but for a time, and when they have evaporated, the rank and frowsy smell of the cocoa-nut oil remains.

Since resin will not make a soap of itself, when treated with caustic leys, it is usually introduced into the soap-pans when the other goods, or fatty matters, have undergone the process of saponification. Indeed, if the resin were put into the pan with the first charge of materials, the caustic ley would seize it at once and dissolve it, and thus prevent the ley from performing its proper function—that of

saponifying the fatty materials. It is commonly the practice to first make the hard soap in the usual way, and when the last charge of leys has been given, and when, after the usual boiling, the ley ceases to be absorbed by the soap, the desired quantity of resin is added gradually, and it is an advantage to have it previously broken up into small pieces. The proportion of resin varies from one-third to one-fourth the weight of tallow, but of course weaker goods will take less.

While the resin is being shovelled in, the boiling must be kept up, with also the addition of caustic ley. The soap is examined from time to time by the soap-boiler, who freely uses his shovel when he considers that the combination of the resin with the soap is near completion. When a sample of the paste, after being allowed to cool, is firm and solid, and exhibits a good grain or "feather" when cut, the soap is finished. The heat being checked by turning off the steam, the soap is allowed to rest, after which the leys are drawn or pumped out, and the process of *purifying the paste* is next resorted to, whereby all impurities of the resin and other materials are deposited below the surface of the soap. For this purpose a quantity of ley at 8° B. is run into the pan, and the steam again turned on, the soap being well stirred for some time with the rake and the boiling kept up for awhile, after which the soap is again allowed to rest, and the ley again pumped out.

A second service of leys at 4° B. is now given, and the boiling and stirring renewed, after which the leys are again allowed to settle, and are then drawn off. A final service of very weak leys at 2° B. is now introduced, the stirring and boiling being resumed as before, when the operation is finished. After a long rest the leys subside, and a skin forms over the surface of the soap, which is skimmed off before running the soap into the frames, and put aside to be worked up with future batches.

In small works the soap is ladled out of the pans into large iron pails by means of a ladle having a very long wooden handle (Fig. 11). This ladle is of considerable

size, and in order to diminish its weight, when full of soap, it is raised by means of a rope running in a pulley by a second man, while the first holds the handle of the ladle, dips it into the soap, and guides it to the pail which is rested upon the edge of the pan, and is carried when full to the soap frames. To hasten the operation of filling the frames, several men, each carrying his own pail, are usually occupied when a "cleanse," as it is termed, is going on. In larger factories, where the application of steam is extensive, the finished soap is pumped out of the coppers into wrought-iron "pots" (Fig. 8) running on wheels, and which are also used for crutching in "liquor" of various kinds; these pots, being wheeled up to the frames, are emptied into them, or the soap is pumped into iron or wooden shoots, one end of which is slung on to the pump, while the other rests on the upper edge of the soap frame, and when the frame is full, the shoot is shifted to the next, and so on.

Cleansing.—When cleansing yellow soaps, great care is necessary to avoid removing, with the finer soap, the dark-coloured compound called *niger*, which forms a stratum between the leys and the pale soap. This dark brown soap derives its colour from the resin and impurities in the ley, and although it possesses all the characteristics of a good soap, is unsalable by itself as a commercial article, and should therefore be worked up with other lighter goods in the making of cheaper soaps.

Another formula for yellow soap is the following:—

Tallow	2,000 lbs.
Resin, about	600 „

These being put into the pan, from 150 to 175 gallons of soda ley at 10° to 20° B. are run in, and the steam turned on. When the materials are melted, the pan is brought to a boil, constant stirring being applied to prevent the resin from adhering to the bottom and sides of the pan. When the mass swells up excessively, the heat must be checked. The boiling is continued for only about two or three hours, owing to the rapidity with which the combina-

tion of the materials and the alkali is effected. The steam being now turned off, the mass is allowed to rest for about six hours, when the spent ley is drawn off and fresh ley is then added, and the boiling resumed and continued for about three hours. After repose for six hours, the ley is again drawn off, and fresh ley run into the pan. The various boilings with fresh leys are continued daily until the soap has acquired the proper consistence, which is ascertained by the soap-boiler pressing a sample previously cooled between his finger and thumb. If the soap divides into hard flakes, it is finished, or nearly so; but if greasy, sticky, and soft, it requires further boiling with fresh ley. If the soap sample is satisfactory, boil briskly for a short time, and then turn off the steam, and throw in a few pails of cold water. After about two hours, the ley is to be drawn off as before. This being done, six or eight pails of water are added and well stirred in, and the boiling briskly pursued. If from samples taken from the paste the ley runs off clear, more water is to be added, and the boiling continued. If it does not separate from the ley, an excess of water is present, and a small quantity—about half a pailful—of strong brine must be added.

Finishing.—One of the most important and delicate parts of the operation is that of *finishing* the soap. When the soap has been properly *fitted,* as above, it will cling to the shovel or trowel and have a gelatinous texture. This being the case, the soap is properly finished. Sometimes, in order to give the soap a bright yellow colour, a little raw (that is, unbleached) palm-oil is added. This oil, while imparting an agreeable odour to the soap, is believed to disguise in some degree the natural odour of the resin.

A quicker process for making yellow soaps than the former is performed in the apparatus known as Papin's digester. The following gives the proportion of goods and ley employed in this process:—

White tallow	800 lbs.
Palm-oil	200 „
Resin (powdered)	400 „
Caustic soda ley at 25° B.	175 gallons.

These materials are put into the Papin digester, and boiled for an hour under pressure at the temperature of 252° Fahr. At the end of this time the soap is finished, and is, after being allowed to cool down a little, run into the frames.

Continental Method.—The French method of making yellow or resin soap in many respects differs from our own system, but since it presents many interesting features we give the process described by Dussauce in his *Treatise*. It will be observed that by this method the resin is converted into a resinous soap, so called, before it is added to the hard soap with which it is to be combined.

First process.—Into a pan holding from 625 to 750 gallons introduce 1,000 lbs. of tallow, which is to be melted by the aid of heat. When melted, it is to be saponified with about 75 gallons of fresh caustic (soda) ley at 7° or 8° B. While running in the ley, the mixture is to be well stirred. All the ley being added, the heat is to be augmented, and the stirring continued for twenty-five or thirty minutes. A white emulsion is thus formed, the ley and tallow having perfectly combined, and a homogeneous paste is the result. An hour after the last ley has been added, the boiling becomes manifested by a tumultuous movement in the mass, and the formation of a very abundant white scum. The heat must now be moderated, and the paste stirred. If these precautions are not sufficient, a few pails of cold water or weak ley are thrown into the pan.

When the effervescence has ceased, the foaming diminishes, and soon disappears entirely. The paste is now homogeneous and white, or of a yellowish tint. Continue to boil gently; by boiling, the mixture becomes more intimate and perfect, and acquires more consistency by the evaporation of the ley. Continue the saponification with leys at 15° to 18° B., which are added in portions of 6 gallons at a time every fifteen minutes for one and a half hour. After the last addition of ley, continue to boil gently for a few hours without adding new doses of ley. By continuing the boiling, the paste is saturated slowly

and gradually with alkali; it becomes denser and firmer, and may then receive stronger leys without fear of the tallow separating from the already saponified mass. There would be no danger of separation if too strong leys were used when the paste is imperfectly saturated with alkali. To prevent this inconvenience, the mass is boiled for a few hours after the addition of the ley. The object of this boiling is to render the union of the molecules more intimate and complete.

The saponification is finished by the addition of 25 gallons of new ley at 20° to 25° B., which is added, 6 gallons at a time, every ten or fifteen minutes. When all the ley is added, the steam is turned off, and the mixture stirred for half an hour. By combining with the strong ley, the paste thickens and acquires a consistency proportionate to the quality of the tallow. The time of this operation varies from eight to ten hours.

Separation is effected with clear leys of coction* at 20° to 25° B. While the ley is being added gradually, the mass is kept constantly stirred. When the quantity of ley added has been sufficient to effect the separation of the soap, a spontaneous change takes place in the condition of the paste, which forms into small grains interspersed with ley. When the separation is complete, which is known by the ley freely separating from the soap, the operation is finished. The stirring is, however, kept up for half an hour or longer, so that the separation may be perfect throughout the mass If "leys of coction" cannot be had, dissolve from 50 to 60 lbs. of salt in about 75 gallons of new ley at 15° to 18° B. The effect will be the same, but the leys will contain an excess of salt. The employment of the former is to be preferred whenever it is possible to obtain them; 75 gallons of such ley at 20° to 25° B., or the same quantity of new ley, after the addition of salt, are sufficient to

* "Leys of coction," or, as we should call them, "salted leys," are passed through the residuum of soda and lime left in the ley vats, which separates any fatty matter they contain, and renders them clear. The leys are passed repeatedly through filters which are richer in soda, and thus acquire additional strength.

effect the separation. After repose for five or six hours, the ley is drawn off.

Boiling.—The ley being drawn off, pour into the kettle 75 gallons of new caustic ley at 24° or 25° B. and apply heat. When the boiling begins, considerable foaming appears upon the surface of the soap, which disperses only when the soap is entirely boiled. If after five or six hours' continuous boiling the ley is still caustic, it must be kept up until all the foam disappears. If, on the other hand, the ley has lost all its causticity, 75 gallons of new ley at 30° B. are to be added, and the boil kept up for four or five hours longer.

The operation being finished, the soap is in the form of very hard white grains, which, when pressed between the fingers, are reduced to scales. The steam is now to be turned off, and the mass allowed to rest for four or five hours, after which the ley is drawn off, the quantity of which will be about 50 or 60 gallons, and of a strength equal to 27° or 28° B.

Fitting is effected by running into the pan 58 gallons of water, and heating to the boiling-point, with constant stirring When the grains of soap are well melted, and have the appearance of flat particles separated from the ley, the operation is finished. It is known that the soap is separated from the ley when by taking it up with the shovel the ley runs off in a colourless stream. The steam is now turned off, or the fire drawn, and the pan is well covered, after which the whole is allowed to rest for seven or eight hours. At the end of this period the pan is uncovered, and the ley drawn off. The soap is then ready to receive its admixture of resinous soap, which is prepared as follows :—

Preparation of Resin Soap.—Put into a pan, capable of holding about 375 gallons, 75 gallons of fresh soda ley at 30° B. Apply gentle heat, and when the ley begins to boil throw in, every five or six minutes (about 15 to 20 lbs. at a time), 1,200 lbs. of resin, previously reduced to a fine powder and passed through a coarse sieve. The mixture must be well stirred during the whole time to

prevent the resin from "clogging" and adhering to the sides of the pan. It is important to moderate the heat, as the resin soap has a great tendency to expand, and an excess of heat would cause it to boil over. The heat, however, must be kept up to near the boiling-point, otherwise the mass will become thick and of a very dark colour. When kept at near the boiling-point it is always perfectly clear, and its colour of a reddish-yellow.

If during the boiling the resin soap rises and threatens to overflow, the heat must be checked, and a few pails of cold water thrown into the pan, which at once has the desired effect. It is absolutely necessary to stir the mass continually, otherwise the resin will agglomerate in masses and thus prevent the ley from acting freely upon it. The saponification of 1,200 lbs. of resin occupies about two hours, and the resulting compound is perfectly fluid, and free from solid particles. The soap being now ready, it is introduced into the tallow soap, and thoroughly incorporated with it by constant stirring. Before doing so, however, it is necessary to pass the resin soap through a coarse sieve, so as to free it from pieces of straw, wood, and other like impurities with which it is frequently contaminated.

It is considered a bad plan to keep powdered resin in barrels, especially in a warm situation, since it is liable to agglutinate and form a more or less compact mass. It is better to have the resin reduced to a powder only a short time before using it.

After being well mixed and run into frames it is sometimes the practice to "crutch" each frame until a pellicle (or skin) forms on the surface, after which the soap is left to cool. Soap thus made is said to be firm and slightly alkaline, producing a good lather even in sea-water. The produce, from the proportions of materials given, should be 2,250 lbs. of good soap. The colour, however, is of a very dark-brown yellow, and, by modifying the process, a lighter-coloured soap is obtained, but the produce is less The second process is as follows:—

Put into the pan 250 gallons of soda ley at 8° or 10° B

Apply heat as usual, and, when the ley is warm, add 1,000 lbs. of white tallow. Boil gently for five or six hours, with occasional stirring. When perfect combination is effected, and a homogeneous paste formed, add 50 gallons of ley at 15° B., and boil to secure the thickening of the paste. Now finish the saponification with 30 or 40 gallons of ley at 20° B., and stir well for half an hour. Turn off the steam and separate the soap with leys of coction (old leys) at 20° to 25° B. in the same way as before.

After a few hours' rest draw off the ley and continue the boiling with 175 to 200 gallons of soda ley at 25° B. If, after boiling for eight or ten hours, the ley is still caustic, and the soap forms thin hard scales when pressed between the fingers, from 600 to 800 lbs. of yellow resin must be added, which gives the soap a fine yellow colour, and the grain of the soap is more homogeneous. The boiling must be continued, and 75 to 100 gallons of ley at 25° to 28° added, which will complete the saponification of the resin. After four or five hours' boiling the ley should still be caustic, when it is known that the soap is finished. A small sample, dropped upon a cold surface, should set hard and firm in a few minutes. After the usual repose the ley is run off.

Now run into the pan from 100 to 125 gallons of ley at 4°, and again boil, with constant stirring, until the mixture becomes liquefied. When all the grains are melted, forming a nearly homogeneous paste, from which the ley, however, separates, the operation is finished; if the ley does not separate, an addition of clear old leys must be made to aid the separation. The steam is now to be turned off and the lid of the pan lowered upon it. After a repose of twenty-four hours the leys, together with all impurities, will have subsided, leaving the pure, finished soap above, which may then be cleansed—that is, put into the frames—in the usual way. When all the soap is in the frames it is to be stirred until cool, and if it be desired to give the soap a slight perfume, an ounce of anise oil for every 100 lbs. of soap may be crutched in. To impart to

the soap an agreeable odour, sometimes 15 per cent. of bleached palm-oil is combined with the tallow, and the whole saponified together. This improves the soap by making it lighter in colour.

Dunn's Process.—This is recommended by the inventor to be performed by steam heat, thus conducted:—Into each of the ordinary soap-pans a circular coil of 1½-inch piping, perforated with holes, is fixed in the well of the pan, just far enough from the bottom to allow the free movement of the stirrer beneath it when it becomes necessary to stir the contents below. The circular coil of pipe is supplied with atmospheric air from a cylinder blast or other suitable forcing apparatus, the circular coil being connected with such forcing apparatus by means of a pipe attached thereto, and rising up to the top of the pan, where it is furnished with a stop-cock and union-joint for the purpose of connecting the parts of the pipe within and without the soap-pan. For a clean yellow soap, put into the pan 90 gallons of leys of the specific gravity 1·14 made from strong soda ash. The fire being kindled, the pan is charged, in the usual way, with, say, 2,050 lbs. of grease, and as soon as the ley is hot and on the boil, or nearly so, the blast is set in action, while a good brisk fire is kept up, so as to bring the materials as near boiling as possible. When the leys are exhausted more ley is gradually added until the grease, oil, or fatty matter is "killed." Then add 550 lbs. of fresh resin, a pailful at a time, with more ley occasionally, until 300 gallons of the above strength have been used, keeping the blast in action the whole time if the fires draw well, but if not, it is advisable to stop the blast for a short time, before adding the resin, to allow the contents of the pan to approach ebullition. When the whole of the resin is melted and completely mixed with the soapy mass, and the strength of the leys taken up, stop the blast, and give a brisk boiling to the contents of the pan, and then let it rest, so that the spent leys may separate and settle. The leys being now drawn off, the soap is then brought to strength on fresh leys as in the ordinary process of soap-boiling.

During the operation of the blast the soap must be kept in what is technically termed an "open or grained state," and for this purpose salt or brine is to be added when necessary. Experience proves that it is better not to make a change of ley during the operation of the blast where the ley of the strength before mentioned is used, but if a weaker ley is employed, one or more changes may be made, as is well understood. It is found desirable that the soap should be kept at what is called "a weak state" during the movement of the streams of air through the materials, otherwise the soap is apt to swell up from the air hanging in the grain, and this is found troublesome to get rid of, requiring long boiling. If dark-coloured materials are used, it is well to keep the blast in operation three or four hours after the resin is melted, provided the soapy mass is kept weak and open-grained. When a charge is to be worked upon the nigre, such nigre should be grained, and the spent ley pumped or drawn off as usual, and the fresh charge added in the manner before mentioned, using less ley in proportion to the quantity and strength of the nigre, taking care not to turn on the blast until there is sufficient grease present to make the nigre weak.

Meinicke's Process requires that the soap-pan should be furnished with a still-head and cooling-worm, since the resin is added in the form of white turpentine, which, during the boiling, gives off its volatile oil as a distillate, which is condensed and saved as a by-product, and thus decreases the cost of the soap. 1,000 lbs. of white turpentine are melted in the pan by steam heat with 800 lbs. of tallow or inferior fat, and when the mixture reaches 108° Fahr. it must gradually receive, with constant stirring, 800 lbs. of caustic soda ley containing 30 per cent. of dry soda. The union of the materials is very prompt at the above temperature, the acids of the resin and grease being completely neutralised and converted into liquid melted soap. The essential oil of turpentine is set free at the same time, and in order to promote its

vaporisation salt brine is added.* The head being carefully luted upon the pan and adjusted to the worm, and the mixture brought to a boil, the steam and vapour of the spirit become united and pass over into the worm, and are condensed. When all the essential oil is distilled over, the remaining soap is finished in the usual way.

Practice shows that the greatest excellence in resin soap is not obtained by adding the resin directly to the oil or paste. The best plan is to make the grease and resin soaps separately and then to mix them in proper proportions. The resin soap is first prepared by stirring 80 lbs. of powdered resin, a little at a time, into 100 lbs. of soda ley at 25° B., and boiling into a perfect solution. The acid properties of resin render the combination easy and prompt, even when the ley is made from a carbonated alkali. The resino-alkaline solution is then to be well stirred into the finished paste, made from tallow, while it is still in the pan; but its temperature should not be above 135° to 140° Fahr., otherwise perfect homogeneity of the mixture cannot be obtained. In this way 15 per cent. of resin may be introduced without materially darkening the colour of the tallow soap. Moreover, the quality of the product is good. Sometimes several per cent. of starch or bran are used to assist the combination of the two soaps. When the soap materials are worked by fire instead of steam the boiling should be continued gently until the paste is uniform throughout, and then the salt is to be added.

Yellow, or resin soap, may be prepared from curd soap by adding to it about 25 per cent. of resin, and then adding from 2 to 4 per cent. of carbonate of soda, and 1 or more per cent. of alum or sulphate of alumina, the whole being boiled with water until a perfect combination takes place. To prevent the resin from becoming precipitated, about 2 per cent. of dilute sulphuric acid (1 part acid to 9 parts water) are stirred into the mixture.

* It is well known that the addition of salt to water enables that liquid to attain a higher temperature than 212° F., the boiling-point of water.

According to Richardson and Watt it is better to saponify the resin and tallow separately, and to mix the two soaps in the pan, and then to boil until a perfect union takes place. Salt is then added, and the soap finished in the ordinary way.

The usual proportions of palm-oil and resin are 3½ parts of the former to 1 part of the latter.

CHAPTER VII.

MANUFACTURE OF HARD SOAPS—(continued).

Treatment of the "Nigers."—Anderson's Process.—Cocoa-nut Oil Soaps Sturtevant's Process.—French Cocoa-nut Oil Soaps.

Treatment of Nigers.—In the manufacture of yellow or resin soaps, the materials, or "goods," are boiled over successive portions of caustic soda ley, of various degrees of strength, or density, as before explained, until the last leys still retain their causticity after continued boiling with the fatty matters. After a few hours' repose the leys are drawn off, and the process of "fitting" commenced To accomplish this, the paste is brought into a thin condition, by adding either very weak leys or water, and the boiling resumed, until the mass assumes the form of an emulsion. The heat is then checked, and the soap allowed to rest for two or three days, when a dark-coloured substance subsides, which is called *niger* or *nigre*. The finished soap is then "cleansed" by pumping it off from the niger into the frames, great care being taken that none of the dark-coloured material is allowed to be drawn off with it.

The niger is usually either worked up in subsequent boils of soap or converted into an inferior quality of yellow soap, according to the requirements of the soap-maker. The utilisation of the niger, however, has frequently proved a source of trouble to the soap-maker, especially when employing large quantities of dark-coloured resin. Mr. Anderson, a well-known London soap-maker, turned his attention to this subject many years ago, and subsequently obtained a patent, from which we extract the following :—

Anderson's Process.—"I find that when curd soap is boiled to strength and subjected to a fitting process, somewhat similar to the fitting process used in making yellow soap, there separates from it a peculiar substance analogous to the niger of yellow soap, and that by removing this niger and boiling the remainder of the goods into curd soap, I obtain a curd soap of better quality than the original charge of goods would yield without this operation. I also find the niger, which I remove, eminently adapted for making mottled soap, to which purpose I apply it accordingly.

"In carrying out my process, I proceed in all respects in the manner practised commonly by soap-makers up to a certain point; that is, I place in the copper the ordinary materials for making curd soap, with the ordinary leys, and boil them together until the goods are to 'strength,' and 'ribbon out' well on the finger; but at this stage, instead of boiling out the head and finishing as heretofore practised, I commence the performance of my process. I pump out the strong ley, on which the goods have been boiled, and treat the goods with successive portions of weak ley or water, and boil them together until they assume the appearance of a fitting yellow copper. This condition being arrived at, I stop the operation, and allow time for the niger to deposit, which may require from twenty-four to thirty-six hours. I now proceed to separate the niger, which I either pump out from under the purified goods to an adjacent copper, or I remove the purified goods from above the niger to an adjacent copper, as I find most convenient; but in either case, the goods being thus deprived of the niger, I add to them the proper finishing ley for curd soap, and boil to a suitable curd, or until the soap is found to be in a condition for cleansing into the frames.

"When I operate upon a charge of very impure materials, or when from any circumstance I consider it an advantage, I repeat the purifying or fitting process one or more times, in which case, after separating the niger, as before, I add to the residual partially purified

goods a ley of moderate strength only (instead of the finishing ley for curd soap) and boil, taking care that no 'head' is formed. I then pump out this ley, and again treat the goods with weak ley or water until sufficiently diluted, so as to perform the fitting process, after which I allow time for subsidence, separate the niger, add the finishing ley, and boil to a curd as before."

He next describes his method of treating the niger, and the way in which he converts it into mottled soap. After separating the purified soap from the niger, as before, he adds to the latter the ordinary ley used for finishing mottled soap, and boils until the soap is fit for cleansing, or framing. The quantity of niger obtained from one boil, however, is not sufficient to make a boil by itself; therefore Mr. Anderson takes the niger resulting from four, six, or more boils of soap, and finishes them in one operation, as above. Sometimes he adds to the nigers a certain quantity of tallow, fat, bone grease, melted "stuff," or other suitable materials, and then proceeds to finish as with an ordinary mottled soap.

Cocoa-nut Oil Soaps.—One of the most important additions to the list of fatty matters suitable for soap-making was the vegetable substance called *cocoa-nut oil* or *cocoa butter*, which, from its extreme whiteness and capability of forming a hard soap, soon became an acceptable substitute in some degree for the more costly tallow. Soap made from this oil, or vegetable butter, is capable of taking up a larger percentage of water—and still form a hard soap—than any other known fatty material. The soap made from it, moreover, is more soluble in saline or "hard" waters—even sea-water—and for this reason it has long been made into a soap called *Marine Soap*, for use on board ship.

Cocoa-nut oil, however, when saponified, has the great disadvantage of imparting an exceedingly disagreeable odour to the skin and even to articles cleansed by its agency; and even when but a small percentage of this substance is blended with other soap materials, its peculiarly offensive odour will rest upon the surface of the skin

for many hours after washing with it. Soap made from this oil, therefore, should never be introduced into toilet or fancy soaps, even in small quantity, except for the very low-priced qualities.

Cocoa-nut oil does not readily saponify with caustic soda leys, when by itself, but when added to tallow, or palm-oil, it does so without difficulty. When saponified by itself it forms a soap of almost unusable hardness, and for this reason, besides its objectionable odour, it is always associated with other fatty materials when employed in the manufacture of soap.

Sturtevant's Process.—One of the earliest processes for making soap with cocoa-nut oil as an ingredient was patented by Sturtevant, in 1841. It consists in first steaming the oil in a wooden vat, and adding to it 6 lbs. of sulphuric and 12 lbs. of hydrochloric acid to each ton of oil, to remove as far as practicable its objectionable odour. After allowing the oil to rest for a while, it is drawn off, and is then ready for the soap-pan.

To make a White Cocoa-oil Soap.—The materials are taken in the following proportions: 2,072 lbs. of cocoa-nut oil, either as it is imported or refined as above; 168 lbs. of olive or other sweet oil, or tallow; 325 gallons of soda ley at 24° B., and 60 gallons of potash ley at 20° B. The cocoa-nut oil, tallow, or oil, as the case may be, are first put into the pan, and heat applied. About 10 gallons of the soda ley is then added, and when the whole materials are united, the same quantity of soda ley is added from time to time, with continued boiling, care being taken that each portion of ley is well combined with the fatty matters before the next is applied. As soon as the whole of the soda ley has been used, the boiling is kept up for about half an hour. The potash ley is then added, gradually, as before, and when the whole quantity has been used, the boiling is kept up for about fifteen minutes, after which about 84 lbs. of common salt are sprinkled slowly over the mass, this operation occupying about a quarter of an hour. The boiling is then continued for about half an hour, after

which the steam is turned off, or the fire drawn, as the case may be.

When the manufacture of the soap is complete, it has the consistence and tenacity, or "closeness" of melted glue. It is now allowed to cool down, and is afterwards cleansed or framed in the usual way. The potash ley is employed with the soda ley only for the finer qualities of soap.

To make Yellow Soap with Cocoa-oil, by the above process, these proportions are given: 1,072 lbs. of cocoa-nut oil; 112 lbs. of raw palm-oil; 336 lbs. of bleached palm-oil; 448 lbs. of tallow; 224 lbs. of resin; 112 lbs. of common salt, and 450 gallons of soda ley at 23° B. All the fatty matters and the resin are first put into the copper, heat applied as usual, and the whole operation conducted in the same way as already described.

There have been numerous modifications of Sturtevant's process for manufacturing soaps with cocoa-nut oil as an ingredient; and, indeed, this useful vegetable product is very extensively used by most soap-makers both at home and abroad, but more especially in this country, where it is employed in enormous quantities. As we have said, however, cocoa-nut oil, unless blended with some other fatty material, does not make a good soap. Tallow or palm-oil, therefore, are employed, in variable proportions, in combination with it, in the manufacture of certain soaps, and it is also the practice to use potash as well as soda leys in making soaps containing cocoa-nut oil. Soap made from this oil being soluble in weak leys and saline solutions, requires a much larger proportion of salt in the process of *separation.*

The proportions of tallow or palm-oil which may be successfully employed with cocoa-nut oil for a genuine—that is, not a reduced, or "liquored" soap—should be 60 parts cocoa-nut oil and 40 parts tallow; or equal parts palm and cocoa-nut oils. For the latter combination, an equal volume of caustic soda ley at 27° B. and a third of a volume of caustic potash ley at 10° B. are used with the boiling until perfect combination takes place. A small

quantity of very weak ley is then added, the temperature of the mass not being allowed to exceed from 180° to 190° Fahr. The boiling should be continued for about two hours, at the end of which time the ley will have become exhausted. A little weak ley is then added, and salt thrown in, with stirring, until a sample, allowed to cool, appears clean, dry, and free from greasiness. If it does not possess these characteristics, and there is no evidence of causticity, a further dose of ley must be added, and if necessary more salt.

If too much heat be applied, the soap will become too thin, causing a separation of the tallow or palm-oil from the cocoa soap, and the same objectionable result will be obtained if there be an excess of salt or ley. In the latter case, the steam is turned off, and a little fresh cocoa-nut oil must be added, with constant stirring, until the proper condition is obtained. The heat is to be kept up for five or six hours, with frequent stirring, so that a perfect and uniform combination may take place. When the operation is finished, the soap is allowed to rest until the following day, when the pan is to be again heated, whereby the union of the alkali and fatty matters becomes more perfect, and the soap turns out harder and better than if framed at once on the completion of the boiling. It is also considered advisable to allow the soap to cool in the pan until it indicates a temperature of 155° Fahr. before removing it to the frames, and to well crutch it, when in the frames, until it begins to stiffen, whereby a more homogeneous condition of the soap is secured. The crutching, however, must not be applied when the soap has cooled down to 130° Fahr., or it will separate from the ley.

If, after allowing the soap to repose in the pan during the night, it should be wanting in strength, a little more ley must be added, until it tastes slightly caustic. Should this not be effectual, warm strong brine must be gradually added, and well stirred in until the desired result is obtained.

Soap containing a large percentage of cocoa-nut oil is

capable of holding in its constitution a very considerable quantity of water, and yet form a hard soap; indeed, in some soaps we have seen, water has been not only the chief ingredient, but *almost* the only one!

French Cocoa-nut Oil Soaps.—In France they make white and tinted soaps from cocoa-nut oil; and since their method of manufacture somewhat differs from that adopted in this country, the following process, given by Dussauce, will be read with interest.

" *White and Rose Soaps.*—For these soaps the oil must be very white and concrete; that of Cochin is the best and the most highly esteemed. Suppose that a soap is to be prepared yielding 500 to 600 per cent., introduce 200lbs. of oil into a sheet-iron kettle (pan) of a capacity of from 375 to 400 gallons. Melt the oil by a gentle heat, and as soon as melted pour in it 50 gallons of new ley of soda ash at 15°, and boil the mixture, adding from time to time small portions of ley at 18° to 20°, until the paste has acquired a caustic taste. When in this state it is a sign that it is entirely saturated. The first operation lasts four hours.

"To harden the soap and make it produce the quantity named above, add to it salt water (brine) at 18° to 20° in the proportion of 5 gallons every fifteen minutes, and at the same time continuing the ebullition. It is in this second stage of the operation that the degree of coction (boiling) of the soap must be ascertained, and for this purpose a certain quantity is taken from time to time and allowed to cool on a dish. When the sample becomes solid by cooling, the operation is finished. Generally the quantity of salt-water used is about the same as that of the ley, and at about the same degree. For the above proportions the operation lasts about seven or eight hours, during which the mixture is constantly kept in a state of ebullition. When the operation is finished the steam is turned off, and the soap, before being run into the frames, is suffered to cool and rest for twelve or fifteen hours.

"If the soap is to be rose, it is coloured as soon as run into the frames, and while yet fluid, with 4 lbs. or 6 lbs. of

vermilion, which is well distributed in the mass by stirring. To have an uniform colour it is important that the paste should be very fluid, for if too cold, a part would remain white."

We shall have again to refer to the subject of cocoa-nut oil soaps when treating of reduced or cheapened soaps, which form an important branch of the soap-making industry, especially in the northern parts of England.

CHAPTER VIII.

MAKING SOAP BY THE COLD PROCESS.

Hawes's System.—Making small Quantities of Soap.—To prepare a White Soap.—Lard Soap by the Cold Process.

It had long been the desire of soap-makers to possess some process of saponification less tedious and costly than the ordinary systems of soap-boiling. It was well known that caustic alkalies would convert into saponaceous matter fats and oils, without the application of heat, and it was also well known that during the process of saponification by the ordinary system of boiling over caustic leys, a considerable amount of glycerine was set free, and which, being a substance soluble in water, passed away with the spent or waste leys, causing a direct and positive loss in the manufacture.

Hawes's System.—One of the most ingenious practical attempts to modify the ordinary system of soap-making was that devised by Mr. William Hawes, a gentleman who had long been connected with the soap trade, and was indeed a member of one of the largest and most enterprising firms in London. The process is well known as the COLD PROCESS, and is thus described by the inventor:—"I take any given quantity of tallow, say 2½ tons, and having melted it, keeping the temperature as low as possible, I mix it with the quantity of alkaline ley which is required to completely saturate the tallow and convert it into soap; and such mixing I perform by mechanical means, and the apparatus or machinery I employ is hereafter described. I use the ordinary ley of soap-boilers, preferring that made from the strongest and purest alkali.

"The saponification of the tallow, or other fatty matter,

may be ascertained by the absorption or combination of the tallow or fatty matter with the ley, care having been taken, in the first instance, to use a sufficient quantity thereof, or about 20 gallons of ley of 17° B. to every 100 lbs. of tallow. It is necessary to state that the proportion of alkali varies with the different fats and oils. The combination of the fatty matter and ley may be effected in an ordinary boiling caldron, with the addition of a machine to produce an intimate admixture, and the minute division of the tallow. The whole apparatus is

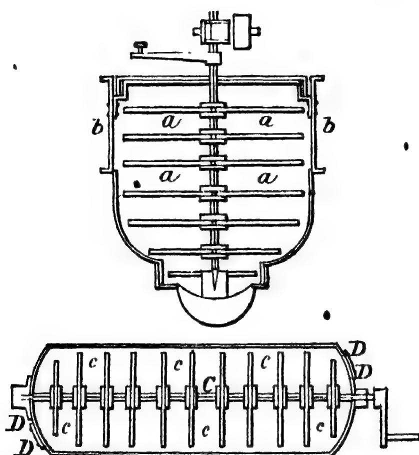


Fig. 17.

represented in the drawings in Fig. 17. It consists of an upright shaft, from which arms, *a a a a*, radiate to the sides of the caldron *b b*. This shaft, either permanently or temporarily fixed in the copper, may be of wood or iron. The mode of fixing the apparatus and the materials used first will depend upon the nature of the caldron and the convenience of the manufacturer. An oscillating motion, or a rotary motion, may be given to the shaft and connected arms by any of the ordinary methods of communicating mechanical power; or a cylinder may be employed with a shaft c, passing through it horizontally, and from

which arms, *c c c c*, may radiate, when a rotary motion will thoroughly incorporate the fatty matter and the ley.

"The size of the cylinder, for about 2½ tons of tallow, will be about 6 feet in diameter and 12 feet in length. It must be provided with convenient doors, D D, for charging and emptying. Motion being communicated to the machine, and the caldron having been previously charged with the tallow, the ley is to be gradually added thereto, and in a short time every particle of the fatty matter will be brought into intimate contact with the alkaline ley, and by such means saponification will take place. The stirring is continued for about three hours, or until the tallow appears completely saponified, as is indicated by the mass thickening, after which it is allowed to stand from one to four days, according to the quantity of the paste.

"Should a cylinder be used, then immediately upon its being charged with tallow, at a temperature just high enough to keep it fluid, the ley is run in, and motion communicated to the shaft, and continued from 3 to 4 hours, or less time, if the mass becomes thick sooner. As the benefit of this process arises mainly from the saponification of the ordinary materials in a comparatively cold state, it is desirable, as soon as the mass thickens, and the ley is absorbed, that the cylinder should be emptied, and the contents turned into an ordinary caldron, preparatory to being finished and converted into yellow soap, by the addition of resin; or into mottled soap or white soap, by the operation of finishing leys, as at present practised by soap-boilers generally. By this transfer from the cylinder to the ordinary caldron, time is allowed for the combination of the tallow and alkali to become perfect."

The adoption of the cold process in this country has not, we believe, extended much beyond the limits of very small operations, such as toilet-soap making, for example. Indeed, the difficulty of obtaining leys sufficiently concentrated, without evaporation, would, to some extent, stand in the way of its extended application. At the present time, however, when soap-makers are supplied with caustic soda in a solid state, which renders it

unnecessary for them to make their leys in the ordinary way, it may be advisable, perhaps, that they should once more take the cold process into consideration. Although soaps made by this process retain more alkali than those made by the ordinary methods of boiling, and would, therefore, be less suitable for toilet purposes, it is certain that good household, or laundry soaps, if carefully prepared, could be advantageously made by this system.

For making small quantities of Soap by the cold process, the ley should have a density of about 36° B. This may be obtained either by evaporating strong new caustic ley prepared in the ordinary way, or by dissolving commercial caustic soda in water until the required strength is reached.

To prepare a White Soap.—Put into a pan, capable of holding about 100 gallons, tallow, lard, or bleached palm-oil, 120 lbs.; cocoa-nut oil, 40 lbs.; apply gentle heat, with occasional stirring, until all the fatty matter is melted. When the liquid grease has attained the heat of about 120° Fahr., add, gradually, 80 lbs. of ley at 36° B., and stir well until a complete union of the fatty matters and alkali is effected. The temperature of the ingredients, at the time of adding the alkali, must not be higher than 122° Fahr., otherwise there will be a separation of the ley from the fatty materials. If the stirring has been diligently pursued, the saponification will be complete in about two hours, and the soap is then ready for the frame. If it is desired to perfume the soap, this should be done while it is in the pan, and before it has had time to cool. It is not a good plan, when making small quantities of soap, to add the perfume after the soap is in the frame, since it is then more difficult to effect a perfect incorporation of the respective materials.

When soap made by the cold process has been in the frame for about five hours, a considerable augmentation of its temperature takes place, owing to the chemical reaction of its constituents, whereby a more perfect combination is effected. In order to favour this reaction, the frame should be closely covered so soon as it has been filled with

the soap. The quantities of materials given should yield about 236 lbs. of soap of a pure white, and, owing to the proportion of cocoa-nut oil, it lathers very freely.

In making coloured soaps by the cold process, it is recommended to add the colouring matter to the fatty materials before the ley is poured in, by which it becomes more thoroughly mixed.

Lard Soap by the Cold Process is made by taking, say, 112 lbs. of lard, and melting as before, at a gentle heat; 28 lbs. of caustic soda ley, at 36° B., are then added gradually, with constant stirring, and when these are well incorporated, 28 lbs. more caustic ley of the same strength are added, and stirred in as before. The temperature of the paste must not be allowed to exceed 149° Fahr. When a sample of the soap is examined, it should feel somewhat unctuous when pressed between the fingers, but exhibit no greasiness. It is then ready for the frame, and after about two days will be sufficiently cold for cutting.

The same process has been applied to making soap from beef marrow, oil of sweet almonds, &c., for toilet purposes. Oleic acid, or red oil, has also been employed in the following way:—1,300 lbs. of caustic soda ley, at 18° B., are run into a pan, and boiled. Then 1,000 lbs. of oleic acid are added, gradually, with constant stirring. The oil, being a fatty acid, is quickly absorbed by the ley, with strong evidence of chemical action, and considerable foaming, which requires to be subdued by continually breaking the foam with a shovel, or other suitable implement. If the paste has a strong caustic taste after two or three hours' rest, more oil must be added, little by little; or, on the other hand, if it has no alkaline taste, additions of ley must be given, until the soap is slightly alkaline. After reposing for about twenty-four hours, the soap is put into frames in the usual way.

CHAPTER IX.

OLEIC ACID.—SOAP FROM RECOVERED GREASE.

Oleic Acid.—Soap from Recovered Grease.—Morfit's System of Soap-making.—Oleic Acid Soaps.—Kottula's Soaps.—Instantaneous Soap.

Oleic Acid.—In the manufacture of stearine for candles, ordinary tallow is boiled in wooden vats by high-pressure steam, with slaked lime, for several hours, by which a *lime soap* is formed. This is transferred to another vessel and treated with dilute sulphuric acid, which, combining with the lime, forms sulphate of lime, which deposits, while the fatty acids (*stearic* and *oleic*) rise to the surface. The mixture of fatty acids, thus formed, is next placed in vessels to cool, and is afterwards subjected to pressure, whereby the oleic acid separates and flows into vessels ready to receive it. At the extensive candle works of Price and Company the vegetable fats are decomposed into their constituents, fatty acids and glycerine, by the action of superheated steam alone, that is, without previous saponification. By another process, palm and cocoa-nut oils are decomposed by strong sulphuric acid at a temperature of about 350° Fahr., produced by superheated steam, and the resulting mass is afterwards distilled by the aid of steam heated to about 550° Fahr. This is called *sulphuric acid saponification.*

It will readily be seen, therefore, that as a by-product of the candle factory, oleic acid must be an abundant soap-making material, and so indeed it is: and, theoretically, it should be convertible into soap (oleate of soda) by means of a carbonated (not caustic) alkali. Taking advantage of this fact, Mr. Morfit, many years since, pursued a long

series of practical experiments with a view to developing a process by which commercial oleic acid, commonly known as *oleine, brown oil,* and *red oil*—resulting from the processes above referred to—could be converted into soap without the employment of caustic leys. The processes which he subsequently introduced included the manufacture of soaps from the fatty acids generally, including "recovered grease," or "sud oil."

Since the treatment of fatty acids with carbonated alkalies, instead of employing them in the caustic state, as in ordinary soap-making, involves the escape of carbonic acid, and a consequent swelling up of the materials when brought in contact, even without boiling, ample room must be left in the pan to allow for the great increase in bulk which occurs after repeated additions of alkali.

Soap from Recovered Grease.—Before giving a brief description of Mr. Morfit's process, it may be well to refer to a series of experiments conducted by the author some years ago, with the object of converting *recovered grease* into a marketable soap. The grease was first melted at a temperature sufficiently high to liquefy it, when small doses of a warm solution of soda crystals were added from time to time, with constant stirring, until effervescence no longer occurred on the addition of the soda solution. The fatty acids being now neutralised, the saponaceous mass was next treated with a solution of *chloride of soda,* with the object of lightening its colour. The powerful bleaching properties of this solution, which it owes to the presence of hypochlorite of sodium, soon affected the colour of the soap, rendering it many degrees paler, but some portion of the colouring matter remained unacted upon by the bleaching liquor, which became evident when the chloride ceased to produce any further effect.

The soap was afterwards boiled over a strong salted ley, and the resulting paste mixed, in varying proportions, with other soaps; but although the *chloride of soda* had diminished the peculiar odour of the grease to some extent, it was found that only a small percentage of the fatty acid soap could be worked up with soaps of better quality, and even then a keen nose would recognise its presence. When

perfumed with nitro-benzol or cassia its odour was effectually disguised, and it could, therefore, be employed in moderate proportions in some kinds of fancy soaps. As a rule, soap-makers have a great dislike to recovered grease, or Wakefield fat, owing chiefly to its odour, but which, after all, is neither so disagreeable nor so lasting on the skin or linen washed with it as that imparted by cocoa-nut oil soaps.

Morfit's System of Soap-making.—This has for its object the conversion of the fatty acids of commerce into soap by means of carbonate of soda, instead of employing caustic leys, whereby the inventor produces soap containing definite proportions of fatty materials, soda, and water, these proportions being determined *before* the manufacture commences. The time occupied in making a batch of soap is stated to be two-and-a-half hours, and in two days after the soap is ready for cutting. Thus four boils may be made in one day in each pan, thereby rendering it unnecessary to keep large stocks of soap on hand.

Although soap made by this system can be "run," that is, cheapened by the addition of large quantities of water and other adulterations, "it does not, in its integrity, contemplate any such degradation. On the contrary, it is designed to furnish soap of the greatest possible excellence at the lowest possible cost, so that the manufacturer may have a creditable means of securing both profit and success against the dishonest competition of very much inferior soaps as made by the older methods."

The fat acids, being already deprived of their glycerine, do not suffer loss in the same way that neutral fats necessarily do in the process of saponification, consequently the whole of the material used, in combination with specific proportions of soda and water, are ultimately obtained in the form of soap.

Amongst the advantages which are claimed for the oleic soaps is the following: they "cleanse better in *cold* and *hard* waters than the highest grade of soap that can be made from neutral fats. Indeed, for most purposes, it is not necessary to use hot, or even warm water to bring out their best effects."

The raw materials employed in Morfit's system include thirty-one varieties of commercial fat acids, but he gives the preference to oleic acid prepared from cotton-seed oil.

In carrying out his process he employs superheated steam, at a pressure of from 50 to 60 lbs. The soap-pan is made of wrought iron, with steam-jacket, and revolving stirrer fixed in strong iron framework. The stirrer consists of a vertical wrought-iron spindle fitted with two wings, or sets of blades, moving in opposite directions, by which a more rapid and complete incorporation of the materials is effected. A simpler arrangement, however, is to fix a series of toothed blades to the sides of the pan, for breaking the paste as it is carried round the mass by a single wing. This is the least costly arrangement, and would be nearly, if not quite, as effectual.

When charging the pan, the proportions of raw materials are either weighed or measured accurately; but, before putting them into the pan, this is first thoroughly heated by letting steam, under high-pressure, enter its jacket. "The charge of red oil or fat acid, say 1,000 pounds, is then to be run into the pan through a sieve, and the heat of the steam raised by superheating. The usual custom, in the absence of a superheater, is to raise the steam in the boiler to a pressure of five to five and a half atmospheres; but this latter should be the extreme. When the introduction of the superheater is employed, its tubes must be kept at a violet or bright violet redness. Care should be observed also to stir well for three to five minutes after drawing up the thermometer, and just previous to adding the alkali liquor, in all those cases where solid fat or resin mixture forms part of the fat stock; otherwise the resulting soap paste will not be homogeneous or handsome." The alkali is not introduced into the pan until the materials have acquired the temperature of 320° Fahr., the highest point it must be allowed to reach.

The alkali liquor for the above quantity of fat acid is prepared by dissolving in boiling water 190 lbs. of soda ash of 52°. The quantity of water must be in the pro-

portion to form soda crystals, namely—62·80 per cent., or, say, 1 gallon of water for every 5 lbs. of ash. This quantity of alkali forms a neutral soap; for stronger soaps, from 210 to 225 lbs. of ash are used. The solution of soda must mark 212° F. before being added to the hot material in the pan, and only from six to twelve minutes' time allowed to run in the whole of the liquor. The stirrer is then set in motion a minute or less after the alkali begins to flow, and is kept up, with the heating, until the process is complete. The brisk chemical action which is set up causes a great swelling of the mass, to allow for which a curb is fixed above the pan. Soon after the last portion of alkali has been run in, the mass begins to subside, and "changes from its spongy state into that of a clear, soft, homogeneous paste, which soon assumes a brilliant appearance. Later it becomes more consistent; and in an hour and fifteen to thirty minutes from the moment that the alkali commenced to fall into the oil, the paste is so stiff and dry that it 'cuts,' or peels from the walls of the pan and the blades of the stirrer." The paste is now sprinkled over with eight or ten gallons of boiling water, the stirring and heating being continued, until the paste, at first quite soft, regains its stiffness. Soap thus made consists of in 100 parts: oleic acid, 65·00; soda, 6·7 to 7·50; water, 27·50.

Instead of employing a solution of soda ash, Mr. Morfit sometimes uses soda crystals, fused in their own water of crystallisation; and since this salt of soda has attained a remarkably low price, it would, doubtless, in this country at least, prove the most facile, as also the most economical, form of soda to apply to this system of saponification.

Oleic acid is extensively used by soap-makers in the ordinary processes of soap-making; but it is generally associated with a considerable portion of tallow or other fat containing stearine, by which a firmer and harder soap is obtained than with oleic acid alone. From 30 to 40 per cent. of tallow is a fair proportion.

To make soap from oleic acid and tallow, the proportions may be—oleic acid, 1,350 lbs.; tallow, 900 lbs.

The oleic acid is first run into the pan and heated, after which, about 100 gallons of old ley, at 22° to 25° B., are introduced. In a short time the oil assumes a spongy condition. If necessary, the operation may be hastened by adding a few gallons of fresh ley at about 28° B. The heat is to be kept up moderately for five or six hours, with occasional stirring, until the grains of soap formed become dissolved. As soon as this is effected, the whole is to be brought to a gentle boil until a thick foam appears on the surface; this foam must be kept under by continual agitation, and if there is a disposition of the mass to rise above the edge of the pan, from 12 to 15 gallons of ley at 20° or 25° B. may be dashed in. It is better, however, to check the heat at times, and to add the leys cautiously, rather than to be compelled to resort to the application of fresh leys to subdue the rising of the mass.

During the boiling, a perfect separation must take place, and the soap appear in the form of small grains. When this condition is arrived at the boiling is to be continued for about a couple of hours, the steam then turned off, and the soap allowed to stand for about eight or ten hours. At the end of this period the leys are drawn off, and the operation of saponifying the tallow commenced. This tallow is first put into the pan, when 75 gallons of fresh ley at 20° to 28° B. are run in, and the whole well stirred, to ensure perfect combination of the leys with the tallow. The mixture is then suffered to rest until the following day, when the steam is to be again turned on. After a while the grains formed during the saponification of the oil gradually disappear, and the tallow begins to assume the usual pasty condition. As soon as this is complete, which is determined by frequent examination of small samples taken from the mass during the boiling, the steam is turned off, and the process of *separation* commenced.

To separate the saponified materials, small quantities of old leys at 22° to 25° are added (about 3 or 4 gallons at a time), when considerable effervescence occurs. Similar doses of ley must be added from time to time, with continual stirring; but each portion of ley must be allowed

to have its full effect before introducing the next, otherwise the uprising of the mass will be so great as to render it liable to overflow. The additions of ley must be made until separation is effected, which may be ascertained by dipping the shovel into the mass in the usual way, when, if the soap appears in small grains, from which the ley runs freely, the operation is nearly finished; but to ensure its perfect completion, 40 or 50 gallons of the same ley are introduced, with brisk stirring for about half an hour.

The soap, which is now in the form of very small grains, is allowed to repose for eight or ten hours, when the ley is drawn off as usual, and the saponification of the soap completed by boiling with two fresh services of leys. In the first service about 90 gallons of fresh caustic ley at 24° or 25° are run into the pan, followed by gentle boiling for eight or ten hours. At the end of this time the leys will be free from causticity. During the boiling, however, to make up for the evaporation which takes place, 2 or 3 gallons of ley should be added about every hour or so.

After the leys of the last operation have been removed, a second service of strong caustic ley is given. This ley should be of 27° or 28° B. From 60 to 75 gallons of this ley are now run into the pan, steam turned on, and gentle boiling applied for four or five hours, during which the soap acquires more consistency, and by the evaporation of water from the ley the mass decreases in bulk. As in the former operation, repeated small doses of strong ley must be added from time to time, and the thick skin which forms on the surface of the soap should be driven into the mass by a stirrer. At the completion of the operation the leys should still be caustic to the taste after a boil of eight or ten hours. The granular soap, if properly finished, should, when pressed between the fingers, form hard and dry scales or flakes, and readily powder when rubbed in the palm of the hand. The steam is now turned off, the cover of the pan lowered upon it, and the soap allowed to repose until the following day, when the ley is drawn off.

Fitting the Soap.—This is accomplished by running into the pan from 100 to 125 gallons of the ley used in the separation, marking 6° or 7° B. The pan is again heated, and when the soap begins to boil, the grains expand, and become more viscid and elastic. The boiling is allowed to proceed gently, and occasionally a few pails of water are spread over the surface of the mass. After four or five hours' boiling the soap assumes a more homogeneous condition, having lost its granular form, and is in clots or lumps, interspersed with ley. The strength of the ley is now tested, which is done by drawing off a little of the ley, and placing it aside to cool. If the ley marks from 16° to 18° B., the operation is complete. If below the former mark, the boiling must be continued until the ley indicates the above density, otherwise the soap will be too soft. On the other hand, if the ley has a density of more than 18° or 12° B., the soap will be too hard. In the latter case, water must be added to reduce the strength of the ley.

The soap being now finished, the pan is covered up, so as to retain the heat as long as possible, by which the leys, together with all impurities, gradually and effectually subside, leaving the purified soap above. The soap is allowed to rest in the pan for at least twelve hours, when the lid is raised, and the scum carefully removed from the surface. It is then ready for cleansing, in the usual way. To insure an uniform condition of the soap, it is crutched in the frames until it has become cool and stiff.

Sometimes, in making soaps with oleic acid as an ingredient, the tallow, or other fatty matters are saponified separately, and afterwards mixed with the oleic soap by crutching in the frames, and if it is desired to give a slight perfume to the soap to disguise the characteristic odour of the oleic acid, a small quantity of nitro-benzol may be crutched in with the soap, which communicates to it the odour of oil of bitter almonds.

A very convenient steam-jacket pan for making soap by the above process, or, indeed, for other systems of saponification, is that designed by Mr. Morfit (Fig. 18). A is the

interior of a cast-iron pan set in brickwork; B a cast-iron jacket into which the pan fits closely, and is rendered steam-tight by proper luting. D D is the steam supply-

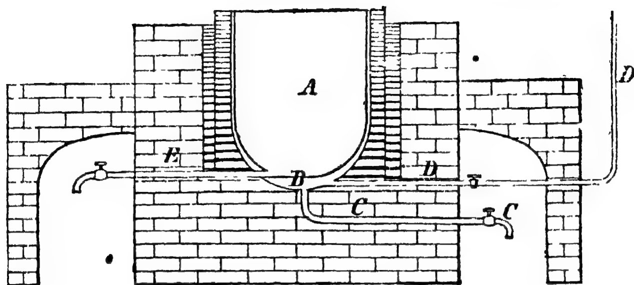


Fig. 18.

pipe. C is an exit-pipe for condensed steam. At E is a discharge-pipe for emptying the pan.

"Red oil" is a very useful fatty material for soap-making. Formerly, stearine was obtained only from tallow, but the vegetable *butters*, or oils—palm and cocoa-nut—are now extensively employed in its manufacture. When stearine is made by *sulphuric acid saponification* and subsequent distillation, the oleic acid is of a brown colour, and is known, commercially, as "brown oil." It has a strong empyreumatic odour, which may be partially removed by passing a current of superheated steam through it, and its colour may be considerably improved by treating it with a small quantity of solution of bichromate of potash and muriatic acid, as in bleaching palm-oil.

These fatty matters do not require caustic alkali for their conversion into soap, since they have already been converted into fat acids, by the various processes employed in the manufacture of stearine for candle-making. It is usual, therefore, to treat these oils with *carbonated* alkali, as before shown. There are, however, several methods of neutralising these fat acids with carbonate of soda, from which the manufacturer may select that which has his preference. It is necessary that the soap-pan should be capacious, or that only a moderate charge of oil should be

operated upon at a time, since a profuse effervescence takes place immediately after the alkali and fat acids come in contact, whereby the volume of the materials is greatly increased. Again, the alkali must be introduced (with brisk stirring) very gradually, until the full proportion has been given.

Oleic Acid Soaps.—In making these soaps it is the practice to estimate the exact quantity of soda that will be required to render a given weight of oleic acid *neutral*, although a slight excess, and for some soaps a larger excess, should be given. Sometimes, as in Morfit's system, soda ash is dissolved in the proper equivalent of water to form soda crystals, or soda crystals are melted in their own water of crystallisation in a jacket-pan, by steam heat. Barilla, kelp, bicarbonate of soda have also been used to neutralise oleic acid, but there can be no doubt that the ordinary soda crystals of commerce, in their fused or melted state, are, from their comparative purity and convenience, to be preferred to all other varieties of carbonate of soda.

The desired quantity of oleic acid being run into the pan (which should be a jacketed pan heated by steam), a moderate heat is applied, and the fused crystals allowed to flow in gradually, with brisk stirring—which is more effectually performed by the steam twirl of Morfit. The heat and stirring must be kept up until the effervescence ceases, and the mass assumes the condition of a homogeneous paste. If a soap of greater firmness is required, *dried* or effloresced soda may be used in place of a portion of the fused crystals. The dried sal-soda is produced by passing currents of hot air through the crystals until they fall into a powder. Or finely-powdered and sifted soda ash may be used for inferior oleic soaps, instead of the dried soda crystals. In using the dry carbonate of soda, however, it must be added after the fatty acid has been brought to a paste with the portion of fused crystals employed.

If resin is to be introduced, the requisite proportion is to be thrown into the previously heated fat acid, and the stirring continued until the whole of the resin has melted, after which the fused sal-soda is to be run in as described.

When the soap has acquired its proper consistence, it is to be shovelled into the frames in the usual way, or may be blended with various proportions of other soaps.

Kottula's Soaps.—A departure from the ordinary system of soap-making was introduced by Dr. Kottula about twenty-five years ago, and at the time attracted much attention. In conducting his process, Kottula adds to ordinary curd, mottled, yellow, or other soaps, made in the ordinary way, fatty matters, lime liquor, concentrated soda leys and alum, with the object of producing a cheaper neutral soap than he believes was hitherto produced. The fatty matters he employs are such as are commonly used by soap-makers. He first boils soda leys until they have acquired the strength of about 30° B., and then adds to them alum, in the proportion of about 3½ lbs. to each cwt. of ley. He then prepares a "lime liquor" by adding to any requisite quantity of water as much lime as it will absorb or take up, and to this lime solution he adds sal ammoniac in the proportion of about half a pound to each cwt. of the solution. Sometimes he omits the sal ammoniac.

The fatty matters, concentrated soda leys, and lime liquor are now added to the melted soap in such proportions that the fatty matters will become duly saponified, and that the soap produced may be of the required description. The whole are then boiled in the usual way. The proportions of fatty matter, concentrated leys, and lime liquor may be varied according to the character of soap required. The following proportions are, however, recommended:—Ordinary fitted soap, or curd soap, 10 tons; fatty matters, 4 tons; soda leys, prepared as above, 4½ tons; lime liquor, 6½ tons. To produce a mottled soap he adds a certain quantity of ultramarine, oxide of manganese, or other suitable pigment, previously mixed with water, and the whole are then boiled together for half an hour, when the soap is ready for cleansing in the usual way.

Instantaneous Soap.—By a modification of the above process Kottula produces what may be termed an *instantaneous soap*, by combining fatty matters with concentrated

soda leys and lime liquor as follows:—He first concentrates the leys, by evaporation as before, until they mark 28° B., when he purifies them by adding to each cwt. of ley from 4 to 4½ lbs. of alum, the whole being boiled for half an hour. The mixture is then removed to another vessel, and a further portion of alum (about 2 to 2½ lbs. to every cwt. of) added, with stirring until it is dissolved, after which the mixture is allowed to settle until it becomes clear.

The lime liquor is prepared as before, with the addition of 1½ to 1¾ lb. of sal ammoniac, the whole being boiled for half an hour. After resting until quite clear, ten tons of fatty matter, with or without resin, and nine tons of the leys as above prepared (or smaller quantities in the same proportions), are said to produce a "superior compact neutral soap," which may be coloured, mottled, or perfumed in the ordinary manner. The rationale of this process is not apparent. If sal ammoniac is boiled with lime-water, it is quickly decomposed. The addition of alum to soda leys effects merely the formation of sulphate of soda and of aluminate of soda, which, if needed, can be procured more cheaply (see page 229).

CHAPTER X.

CHEAPENED SOAPS.

Normandy's Process.—Silicated Soaps: Sheridan's Process.—Gossage's Processes.—Preparation of Silicate of Soda.—Preparation of Silicate of Potassa.—Mixing Silicate of Soda with Soaps.

PREVIOUS to the abolition of the excise duty on soap, the addition of any foreign substance to soap, with a view to cheapen it, was resisted by the Excise Board and its myrmidons with wondrous pertinacity; and since the excise officer was ever on the premises, like a man in possession, and regularly locked up each copper when the hour for closing the factory arrived, evasion of the law was not easily managed. At this period, any process, patented or otherwise, which involved the introduction into soap of any substance other than fats, oils, leys, and salt (on which latter substance there was also a high duty) was a criminal offence. During this period, the high prices of materials and the increasing demand for soaps rendered cheapening processes necessary for the public convenience; but, until the duty was subsequently abolished, improvements in this direction could not be taken advantage of by the more enterprising firms, who were both willing and desirous to adopt improvements of a satisfactory nature.

Dr. Normandy's Process, for cheapening soap by the addition of sulphate of soda, met with strong opposition from the excise authorities, and, instead of reaping the advantage of his ingenuity, he was subjected to constant irritation and official interference. Normandy's process, which has since been subjected to modifications, according

to the requirements of the manufacturer, is briefly as follows:—The soap being made in the ordinary way, and transferred to the cleansing copper, sulphate of soda, in the proportion of 20 lbs. for every 80 lbs. of soap, and 4 lbs. of carbonate of soda or of potash, or 2 lbs. of each, are thrown into the hot soap, and the whole well stirred until the mass is perfectly homogeneous, when the soap is ready for framing in the usual way.

The sulphate of soda, and carbonate of soda or potash, may be introduced in the liquid state (that is, fused in their water of crystallisation). Supposing the quantity of soap to be treated is 3 tons, the sulphate and carbonate of soda are to be put into the "pot," or lower part of the cleansing-copper, in the proportion of 28 lbs. of the former and 4 lbs. of the latter for every 80 lbs. of soap, and then allowed to fuse into a liquid state. The soap is then to be run into the cleansing-copper with constant stirring, while the soap is being transferred, until the mixture is complete.

Sometimes it is desirable to dissolve the sulphate and carbonate of soda in water, in which case, 3 cwt. of water, 2 cwt. of sulphate of soda, and 1 cwt. of carbonate of potash (or ½ cwt. of each of the two latter) are put into the cleansing-copper and dissolved by heat, as before; after which the soap is transferred from the boiling-copper, when 21 cwt. more of sulphate of soda and 3 cwt. of carbonate of soda or potash are to be added (or half this quantity), and the stirring continued as before until a perfectly homogeneous mass results.

It is now commonly the practice to melt the crystals of sulphate of soda (Glauber's Salt), or carbonate of soda in a steam-jacketed pan, and to ladle the liquid as required into the melted soap, after it has been put into the frames, when the union of the materials is completed by crutching in the ordinary way; or the liquid salts are introduced by means of the steam-crutch.

One of the most important advantages of the above process—which, as we have said, is subject to many modifications—is that the sulphate of soda, when mixed with

soap deficient in hardness, through poorness of the materials of which it is composed, crystallises throughout the mass, and thereby gives it an artificial hardness, which prevents it from washing away too freely in the hands of the laundress. Indeed, soap may be rendered so hard by employing large quantities of this salt, as to resist the strongest pressure of the thumb. When it is employed in excess, however, it is very liable to *effloresce* on the surface of the soap, rendering it not only unsightly but, to some extent, unsalable.

Silicated Soaps: Sheridan's Process.—Of all the numerous cheapening substances which have been introduced into pure soaps, the *silicate of soda*, or *soluble glass* may be deemed the most important, since it not only favours the introduction of a large percentage of water in certain kinds of soap, but it also possesses in itself a high detergent property. The merit of applying silicate of soda to soap is due to Mr. Sheridan, who obtained a patent for his process as far back as the year 1835, at which period, however, owing to the then existing excise laws, it could not receive that extensive adoption which has fallen to the lot of subsequent processes based upon his original and most ingenious invention.

Although the silicate of soda, or soluble glass, is now an extensively-manufactured article of commerce, and forms a necessary item in the long list of soap materials, it may be interesting if we give a brief outline of Sheridan's original process. He first formed a "detergent mixture," by boiling calcined quartz or flint (previously ground to an almost impalpable powder) or sand, with strong caustic soda, or caustic potash leys; the proportions being one part by measure of ground calcined flint or quartz to two parts of either caustic alkali, marking 28° B. These were boiled together for about eight hours, with continual stirring, until they became a "homogeneous mass, having the appearance of saponified matter" [a viscous condition]. When in this state it was ready to be mixed with soap, which was done by introducing the "detergent mixture," as Sheridan called

it, a pailful at a time, with constant stirring, until the desired quantity had been incorporated with the finished soap. The silicate solution must be as nearly as possible at the same temperature as the soap, and the mixture effected by the ordinary method of crutching.

Respecting the proportions of silicate of soda which may be added to soap, Sheridan says, "I find that in curd soap equal quantities, by weight, of each will answer best; in yellow soap about one-tenth more of the detergent mixture may be used." He, however, recommends small sample batches, in varying proportions of soap and silicate, to be made to guide the soap-boiler as to the relative quantities of each which may be blended judiciously to form the quality of soap he may wish to produce. He recommended mixing the soap and silicate of soda in a small pan capable of holding about half a ton, and from this it was transferred to an ordinary frame.

The same invention related to the manufacture of *soft soaps*, for which the silicate of potash, before referred to, was applied, and which will be considered under the head of Soft, or Potash Soaps.

Gossage's Processes.—Nearly twenty years after the publication of Sheridan's process, Mr. Gossage, of Widnes, obtained a patent, namely, in 1854, which bears a close resemblance to Sheridan's, except in the method of preparing the silicates of soda and potash. In the patent referred to Gossage says, "The object of my invention is to provide a soluble compound for mixing with true soap, which compound shall possess in itself chemically detergent properties, and be obtained at a low cost, thereby enabling me to produce a compound soap the cost of which is greatly reduced, but possessing valuable detergent properties, independently of the true soap contained in such compound. When silica is combined with soda or potash in such proportions that the alkaline matter present is about double the quantity usually contained in glass, a compound is obtained which is known to chemists as 'soluble glass,' and when a solution of this compound is prepared, by boiling it with water, and this solution

concentrated (by evaporation of water therefrom), a thick viscous compound is obtained, which is easily redissolved by the addition of water. This thick viscous compound contains alkali in a state of weak combination with silica, and is therefore analogous to true soap,* which contains alkali in a weak combination with fatty acids, and it is to this condition of alkali being weakly combined in both compounds, and therefore ready to enter into other combinations, that the detergent properties of true soap and the soluble compound of silica and alkali are attributable. When the thick viscous compound of silica and alkali (above mentioned) is added to true soaps, and intimately mixed therewith, a compound soap is obtained, at a low cost, possessing valuable detergent properties."

Preparation of Silicate of Soda.—Gossage prepares silicate of soda or silicate of potash by fusion, much in the same way as that adopted in the production of ordinary glass. He mixes together about equal parts of dry carbonate of soda and clean sand, to which is added one part by weight of ground coke or charcoal for each nine parts by weight of carbonate of soda. This mixture is melted in the same way as mixtures of sand and alkalies are in glass-making. The melted mass is afterwards poured into cold water, which renders it more friable. The product is then ground to a fine powder, and afterwards dissolved by boiling in three or four times its weight of water. During the boiling liquid caustic soda is sometimes added. After reposing for a few hours the clear liquor is drawn off and concentrated by evaporation until it assumes a viscid condition suitable for mixing with pure soap.

Preparation of Silicate of Potash.—In making silicate of potash, twelve parts of dry carbonate of potash, two parts of sand, and one part of coke or charcoal are mixed together, and the whole melted and treated as above. In place of sand, ground felspar may be used, in which case three parts of this mineral are substituted for two parts of sand, and only one-half the quantity of alkali is used. Sulphate of soda or sulphate of potash may be used instead

* Or, as Sheridan said, "Having the appearance of saponified matter."

of the carbonates of soda or potash in making the "soluble glass," in which case three parts of either sulphate are substituted for two parts of either carbonate, and four times the quantity of coke or charcoal above given.

Gossage subsequently found that silicated soaps could be advantageously produced from pure soaps containing a much larger proportion of resin than was usually employed in the manufacture of hard soaps, whereby a very economical and low-priced soap could be produced. In preparing a genuine soap he used not less than one part of resin for each two parts of tallow or oil, or a mixture of both; and when the soap had been fitted, and was ready for cleansing, he introduced the viscous solution of soluble glass in certain proportions, the specific gravity of which should be about 1·500 (water being 1000).

When manufacturing genuine soap, to be afterwards converted into silicated soap, in which a larger proportion of resin than six parts for each ten parts of tallow or oil, or a mixture of each, is used, he prefers to finish the soap as a "stiff curd," in which state the viscous solution of soluble glass is introduced. In mixing the soluble glass with soap, it is recommended that the first portion of the solution should be of the specific gravity of about 1·300, and the remaining portions at increasing specific gravities, until the whole quantity of the silicate solution averages the specific gravity of 1·500.

Mixing Silicate of Soda with Soaps.—For effectually mixing genuine soaps with silicate of soda, Mr. Gossage employs certain apparatus, the simpler form of which is represented in the drawing (Fig. 19). A circular tub, A, having the form of an inverted cone, is fitted with a series of blades projecting, *b b b*, inside the vessel. A vertical shaft, B, also furnished with a series of blades, *c c c*, is supported by a footstep, *d*, fixed at the bottom of the vessel, and by a journal, adapted to a metallic bridge-piece, *e*, which is fixed over the tub and secured by screw-bolts to its sides. A bevelled cog-wheel is adapted to the upright shaft, and a horizontal shaft, also provided with a bevelled cog-wheel, and supported by suitable bearings, is attached

to the tub, the two wheels being so placed that they will work in gear with each other. A driving pulley is attached to the horizontal shaft, which is set in motion in the usual way when the apparatus is required to be used. The

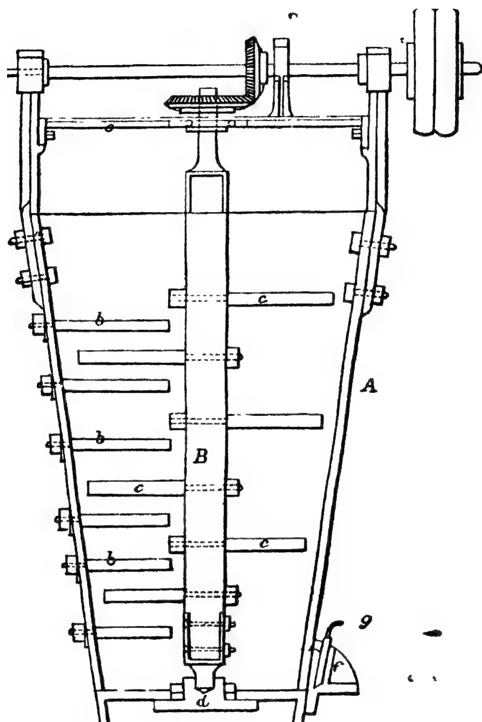


Fig. 19.

diameters of the pulleys and wheels are so regulated that the upright shaft may make from sixty to eighty revolutions per minute. A spout, *f*, is attached to the lower part of the tub, with a stopper, *g*, through which the contents of the vessel are run off.

"When I am about to use my improved apparatus,"

says the patentee, "for the production of compound soap, by mixing genuine soap with viscous solution of soluble glass, I ascertain previously the highest temperature at which the mixture of such genuine soap, with the proportion of the viscous solution employed, will become too thick to admit of its flowing from such mixing apparatus. I then prefer to make a preparatory mixing, by means of paddles or crutches, of the genuine soap with the viscous solution employed, in such a tub or vessel as will contain about half a ton of soap, adding the soap and viscous solution at such a temperature as will yield a mixture having a mean temperature about ten degrees higher than the previously ascertained temperature before referred to.

The mixture is now introduced into the mixing apparatus, the shaft of which is then set in motion, and when the incorporation of the silicate and soap is complete, the sliding stopper is withdrawn, and the contents of the vessel allowed to flow out, and be conveyed to the frames. During the rotary crutching, or mixing of one batch, further quantities of the soap and silicate are allowed to undergo the preparatory process of mixing as before.

Another modification of the former processes consists in mixing the soluble glass, in a viscous state, with soap made by combining fatty matters with leys, containing such a proportion of alkali in solution as will be sufficient to perfect the conversion of the fatty or resinous matters into soap in one operation (as in Kottula's process), without necessitating the removal of exhausted leys, and adding a further quantity of ley to complete the saponification.

The following is another process, formerly patented by Mr. Gossage:—60 cwt. of palm-oil, or tallow, and 20 cwt. of resin are melted together, or either of the following formulæ may be used if preferred, namely, 30 cwt. palm-oil or tallow, and 30 cwt. of oleic or stearic acid; or 30 cwt. of palm-oil or tallow and 30 cwt. of cocoa-nut oil. 30 cwt. of any of the above mixtures of fatty or resinous matters, in a melted state, and at a temperature of about 150° Fahr., is added to a mixture consisting of 80 cwt. of solution of silicate of soda at a specific gravity

of 1·300°, and 20 cwt. of caustic soda ley of the specific gravity of 1·180°, the mixture being also at a temperature of 150° Fahr. The whole are mixed together by agitation.

Into an ordinary soap-copper is then put 30 cwt. of the same mixture of fatty, oily, or resinous matters, and 40 cwt. of caustic soda (sp. gr. 1·180) mixed with 20 cwt. of water, the whole being boiled together until saponification is complete. The former mixture of fatty matters, silicate of soda, and soda leys is then added to the above, and the whole again boiled together, when 3 cwt. of common salt are to be added. The boiling is to be continued until the mass is reduced to about ten tons, when it is to be cleansed as usual.

CHAPTER XI.

CHEAPENED SOAPS—(continued).

Dunn's Process.—Guppy's Process.—Thomas's Process.—Potato-flour in Soap.—China Clay.—Douglas's Improvements.—Fuller's Earth Soap.—Davis's Process.

In making silicated soaps, the strength or density of the solution of soluble glass is regulated by soap-makers according to the quality of soap they desire to produce, and the nature of the "goods" employed in the manufacture—some materials forming a perfectly hard soap with a very large admixture of the silicate. It must be borne in mind, however, that whenever soluble glass is employed, and in however small a proportion, the insoluble base, *silica*, becomes separated in washing, leaving a deposit, more or less, upon the surface of the skin or linen cleansed by it. Moreover, although silicated soaps possess good detergent properties, they are not agreeable for toilet purposes, since they are very apt to impart an unpleasant roughness to the skin soon after using them.

Dunn's Process.—The object of this process is to combine silicates of soda or potash with soap, under pressure, whereby a more perfect union is stated to be effected, and the same method is said to be applicable to ordinary soaps. For yellow soap Mr. Dunn takes the materials in the usual proportions,—say, tallow 7, palm-oil 3, resin 3 parts, and caustic soda leys at 21° B.. from 140 to 150 gallons. These are placed in a steam boiler (Fig. 20), which is furnished with a man-hole, safety-valve, and all other appendages of such an apparatus, with a thermometer dipping into a chamber of mercury. At A is a feed-pipe, and at B a

discharge-pipe, from which the finished soap passes to the receiving-pan at c. The fire being kindled, the boiler is heated until the pressure at the safety-valve is sufficient to enable the temperature in the boiler to rise gradually up to 310° Fahr., at which point it is allowed to remain for about an hour, when the contents of the boiler are discharged into the pan c, and the process is complete. Dunn prepares his silicate of soda or potash also under pressure, by placing in the boiler crushed flint or quartz and caustic soda or potash, in the proportion of 1 cwt. of silica to 100 gallons of ley at 21° B., and the whole is

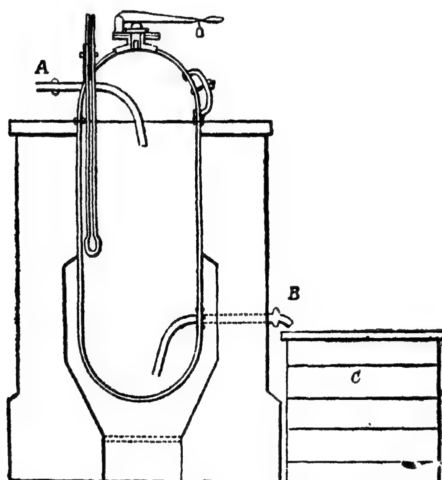


Fig. 20.

then heated as before, under a pressure, until the temperature of the boiler indicates 310° Fahr. The steam pressure should be equal to from 50 to 70 lbs. to the square inch, and after about three or four hours the silicate is to be discharged by the exit-pipe, and is then ready for mixing with soap in any required proportions.

Guppy's Process.—An improvement was made in the above process by Mr. Guppy, who employed stronger leys, which were injected from a reservoir into the boiler

gradually by means of a force-pump. Guppy's proportions of materials are—for every 24 lbs. of tallow, 10 pints of caustic soda ley at 17° B. are put into the boiler and heated to 300° F. Afterwards about 30 pints of ley at 25° B. to every 24 lbs. of tallow are then introduced by means of a force-pump, and the heat continued for two hours at from 300° to 310° Fahr., when the saponification is complete. Samples are taken from time to time by means of a small cock fixed for the purpose. This modification of the former process is said to be more economical and quicker in its results.

Thomas's Process—In some of the processes we have described sulphate of soda, carbonate of soda, or both in combination, and silicate of soda or potash have been employed as cheapening materials for soap. By this process, however, silicate of soda or potash is used conjointly with sulphate or carbonate of soda or potash in combination with soap, by which a supposed advantage is gained over their separate use. The silicate and carbonate of either alkali may be either mixed before adding them to the soap, or they may be introduced separately, but the patentee usually introduces the sulphate or carbonate of soda in crystals, and then adds the silicate in solution at a specific gravity of about 1·600. The sulphates or carbonates may, however, be used in solution. It is preferable to use the soap as taken out of the pan at a temperature of from 170° to 200° Fahr., the proportions of soap and the salts being regulated according to the quality of soap to be produced. The following proportions are said to yield good results:—I. Soap, 15 cwt.; sulphate of soda crystals, 4 cwt.; silicate of soda (specific gravity 1·600), 1 cwt. II. Soap, 12 cwt.; sulphate of soda crystals, 6 cwt.; silicate of soda (specific gravity 1·500), 2 cwt.

To combine the soap with the salts, a closed vessel is employed, surrounded by a jacket, and the vessel is fitted with a steam-tight cover, with man-hole and lid for charging, and a vertical shaft working in a steam-tight stuffing box with arms attached, extending to within half an inch of the sides, and with vertical blades attached to

the arms. The soap is first introduced through the man-hole and the shaft set in motion when the salts are added, and the rotary motion continued until perfect combination is effected. If the mass becomes too stiff the temperature is raised by turning on the steam to the jacket, or into the vessel itself, and the soap when finished is drawn off or blown out, through a passage or cock, at the lower part of the vessel, and is conveyed to the frames in which it is crutched for a time, as is usual with soaps of this kind.

Potato-flour in Soap.—The ingenious inventor of silicated soaps (Mr. Sheridan) conceived the idea of blending with pure soap certain proportions of potato-flour, which he carried into effect in the following way:—Equal parts by weight of potato-flour and cold water are mixed thoroughly, so that no lumps may remain. To every 12½ lbs. of the flour used 37 lbs. of a solution of alum, free from sediment, are added, and the whole well incorporated by stirring. To this mixture is added, in the same proportion as before, namely, for every 12½ lbs. of potato-flour used, 40 lbs. of soda or potash leys at 22° B., and the whole mixed together into a homogeneous mass. For making hard soaps the soda leys are to be used.

The above mixture, which is called the "detergent mixture," is now to be heated at a temperature of from 170° to 190° Fahr., but not higher, for from three to five hours, which is best done by steam in a jacket-pan. During the heating the mixture is to be constantly stirred, to prevent it from adhering to the sides of the pan. The mixture, being now ready, is to be added to melted soap, when it is in the proper condition for cleansing. This is best done by placing the soap in a half-ton pan, when the detergent mixture, while still hot, is to be added, a pail-ful at a time, and well crutched in, in the same way that curd soap is crutched. It is necessary that the detergent mixture and soap should be as nearly the same temperature as possible. The quantity of the detergent mixture which is to be added to the soap may vary from one-fifth to one-third by weight; but the soap-maker should determine this by making small samples with different

proportions of the detergent mixture and allowing them to cool. After well crutching the soap and detergent mixture, the compound soap is put into the ordinary frames.

China Clay (Kaolin) in Soap.—The introduction into soaps of solid ingredients which possess no detergent properties in themselves, cannot be commended, neither should this system of adulteration be encouraged by soap-makers, whose success in the manufacture of soap depends upon their reputation for honesty. If the public *will*, however (as they certainly do in the present age of adulteration), encourage cheap and worthless goods in preference to genuine articles, even the most scrupulous must yield to the demand.

Douglas's "improvements" in the manufacture of soap consists in combining any variety of clay with soap; the most approved substance, however, is *kaolin*, or China clay (a silicate of alumina), which abounds extensively in some districts in Cornwall. The clay is placed in a vessel, heated by steam or otherwise, and worked up into a paste with water, the clay being in the proportion of about 25 per cent. of the mass. Heat being applied, the mixture of clay and water is effected by constant stirring. To this is then added a saturated solution of salt in the proportion of about one-twentieth part of the whole. The proportion of the above mixture to be added to melted soap is regulated by the requirements of the manufacturer—the utmost extent being 30 per cent. of the clay. Persons of peculiar fancy use these argillaceous soaps for toilet purposes.

Fuller's Earth Soap.—Of all the solid matters which have been mechanically combined with soap, the mineral substance known as fuller's earth is undoubtedly the best. Moreover, being in itself a detergent, its combination with soap partakes less of the character of a mere adulterant than other argillaceous (or clayey) substances. Indeed, long before soap was known, this substance was employed as a cleansing medium.

It is nearly twenty years since the author introduced into the market a combination of soap and fuller's earth,

under the title of *Fuller's Earth Soap*; but although it met with considerable approbation as an agreeable toilet soap, it failed to command an extensive sale. The method of preparing it is given below, but it should be stated that the object was to introduce into the soap the utmost amount of the detersive earth that could be mechanically mixed with it, in order that the latter, and not the former, should be considered the active ingredient.

The fuller's earth should be of the best commercial quality, which occurs in large lumps, and first dried in an oven, at a moderate heat, the object being merely to expel the moisture with which it is associated, so that it will freely *slaken* when again moistened with water. It is a peculiarity in this, and other clays, that they are more friable, after being dried, and then moistened. When the fuller's earth is thoroughly baked, the lumps are placed on a flat slab, with a ledge round it, and are then sprinkled with water until they cease to absorb that liquid, which is ascertained when an excess of water ceases to be absorbed, or taken up by the dried earth. When the lumps have thus become saturated, the clay becomes very soft and pasty to the touch. It is now to be dried at a very gentle heat, until all the water is expelled, when it will assume the form of a fine, but not impalpable powder. In this condition it is easily reduced to a powder, but in case there may be any lumps present, it should be sifted through a fine gauze-wire sieve.

To mix the fuller's earth with soap (resin soap by preference), the latter should be put into a steam jacket-pan, and the earthy powder spread over the surface, a little at a time, with constant crutching, until the full quantity has been introduced. Bearing in mind, however, that the dried clay is highly absorbent, after a certain quantity has been worked in, the mass will become considerably stiffened, and thereby render the crutching both laborious and difficult, therefore, to make up for the water expelled from the soap by evaporation, a small quantity of hot water may be added, if necessary, and finally, any desired perfume added, if for a toilet soap. In this way

it is possible to introduce at least one-third of fuller's earth, or one part to two parts of soap, whereby a very useful compound is formed which, as a skin soap, is most agreeable, and is, when not perfumed, specially serviceable as a nursery soap.

Davis's Process.—Another method of blending fuller's earth and other substances with soap, is that proposed by Mr. Davis, in which pipe-clay, pearlash, or calcined soda, are introduced. When pearlash, or soda, is employed it is first calcined and then ground up with the fuller's earth and clay until intimately mixed, and in this condition they are to be incorporated with the soap. The proportions are—To every 126 lbs. of soap, in a melted state, take 50 lbs. of fuller's earth, slaked or dried, 56 lbs. of dried pipe-clay, and 112 lbs. of calcined soda or pearlash, all in powder, and sifted as finely as possible. Incorporate the whole by stirring or crutching, as quickly as possible before the pasty mass cools. If it is desirable to omit the fuller's earth in the above formula, the proportions are to be:—soap, 120 lbs.; dried pipe-clay, 112 lbs.; and calcined alkali, 96 lbs. This soap is said to be useful for general washing purposes at sea, and for washing white linen in salt water.

For soap to be used for washing white linen in fresh water, 112 lbs. of soap, 28 lbs. of dried pipe-clay, and 36 lbs. of calcined soda are used in the above process.

CHAPTER XII.

DISINFECTING SOAP.

Chloridised Sanitary Soap.—Bleaching Soap in the Pan.—Pearlash added to Combined Soap.—Lime Soap, by Lunge's Method.

Chloridised Sanitary Soap.—The object of the process, for which the author obtained a patent in 1865, was to impart to ordinary household and toilet soaps, disinfecting, deodorising, and bleaching properties, and at the same time to increase the detersive action of the soap. The material employed was *chloride of soda*, which was prepared by mixing chloride of lime* (bleaching powder) worked up into a thin paste with cold water, with a solution of carbonate of soda—either soda crystals or soda ash being used, according to convenience. The double decomposition which takes place when the two substances (chloride of lime and soda) are brought in contact, results in the formation of chloride of soda in solution, and carbonate of lime as an insoluble precipitate.

To make the Disinfecting Mixture.—Take of chloride of lime 28 lbs. and mix into a thin paste or "cream" with about 10 gallons of cold water, then dissolve 32 lbs. of soda crystals in 18 gallons of hot water. The solution of soda is to be placed in a clean tub or cask (a steamed oil cask will do), and a crutch placed in it for stirring. Two strips of wood are then laid across the upper rim of the vessel, upon which a fine wire-gauze sieve is to be rested. The chloride mixture is now to be ladled into the sieve, and as each ladleful is introduced the contents of the vessel are to be briskly stirred. The object of passing the chloride

* Otherwise chlorinated lime.

through a sieve is to keep back unmixed lumps, fragments of wood, and other impurities. When nearly all the chloride has been added, with constant stirring, the mass thickens and in a few moments after it becomes more fluid, when the decomposition is complete, and the mixture is ready for use.

The proportion of soap for one frame being put into the frame, the mixture is to be added a pailful at a time, and well crutched by one, or by preference two men, care being taken to clear the soap from the sides and ends of the frame, otherwise dark patches of the original soap will appear when the mass is cold.

The best kind of soap for converting into the "sanitary soap" is a stiff curd, from which the leys have been allowed to drain *as much as possible*, by several hours' repose in the soap-pan. It is also important that the soap should not be of a higher temperature than 130° to 150° F., otherwise separation may occur. This is, however, readily avoided by adopting the precaution suggested. After crutching, the soap is allowed to cool as usual, and is then cut into bars in the ordinary way.

When this soap is prepared from ordinary London grey-mottled soap, the bleaching property of the chloride of soda will manifest itself by the superior colour of the soap, which, while preserving, to some extent, the mottle or "strike," will be considerably improved; and if the original soap has been made from rank and coarse goods, the chloride will have diminished their disagreeable odour in a great degree. Indeed, the chlorinated soap has an exceedingly agreeable odour as compared with ordinary mottled soaps. It will be observed that, in adding the above mixture to soap, the carbonate of lime resulting from the decomposition also enters the soap, and this might naturally appear objectionable. It is but right to mention therefore that when the mixture is properly prepared, and its incorporation with the true soap satisfactorily accomplished, the impalpable particles of carbonate of lime are not perceptible, neither do they present any inconvenience when the soap is used for laundry or other purposes, while,

on the other hand, its very superior cleansing and bleaching powers render it infinitely more economical to the user. It has been found in large laundries that women whose hands had suffered much from using mottled soap containing caustic ley in its interstices, were agreeably surprised to find their excoriated hands assume the normal condition after using the chloridised soap for a short time. Indeed it is a fact that this compound soap imparts a most agreeable smoothness to the skin, which, after using it, becomes remarkably soft and glossy.

Instead of employing carbonate of soda in preparing the chloride of soda, as before described, a solution of silicate of soda (glass liquor) may be used, for which suggestion the author was indebted to his friend Mr. John Cowan, of the Barnes Soap Works. In this case, the following proportions may be taken.

Chloride of lime worked up into a thin paste or cream, as before 20 lbs.; silicate of soda, 20 lbs., dissolved in warm water until it marks about 18° Twaddell. These materials are to be mixed and used in the same manner as before, and the proportions of the chlorinated mixture may be regulated according to the nature of the soap, from four to six 60 lb.-pailfuls being a fair proportion for a half-ton frame.

When the chloridised soap has been well prepared, linen and floor-boards washed with it become remarkably white with comparatively little labour, which facts have been demonstrated by repeated and extensive trials.

It should be mentioned that the chloride has the effect of considerably hardening soaps free from resin, and is specially available for soaps containing a large percentage of cocoa-nut oil; and even after being heavily "run" or liquored with silicate solution, several 60 lb. pails of the chloride mixture may be added with advantage. Soap of this kind however should be crutched, as usual, until beginning to "set."

An important application of the chloride of soda is in bleaching soap made from the darkest nigers, which may be effected by introducing certain proportions of the

chloride, until the colour of the soap is evidently and sufficiently improved.

Bleaching Soap in the Pan.—When soap is made from dark-coloured goods, or from materials in which a certain quantity of dark-coloured fatty matter forms a part, a considerable improvement in the colour of the batch may be made by adding a moderate quantity of *solution of chloride of soda* after the first operation of saponification is complete. The chloride solution is prepared in the same way as described in the first formula, but twice, or even three times the quantity of water should be applied, in order to facilitate the deposit of the carbonate of lime. After the materials have been mixed with, say, 28 gallons of water for each 28 lbs. of chloride of lime and 32 lbs. of soda crystals used, about 56 gallons more cold water are added and the mixture well stirred, after which it is allowed to repose for a few hours, when the clear liquor (which has a slightly greenish tint) may be drawn off as required, and as much of it spread over the boiling contents of the pan by means of a ladle or swimmer as may be found necessary to bleach or decolour the saponified mass.

When all the liquor has been drawn off the residual carbonate of lime, a quantity of fresh water should be added with brisk stirring, in order to wash out, as far as practicable, the remaining chloride, and the weaker liquor thus obtained may be used in place of water in future batches, as in making ordinary leys. Although the process has been extensively adopted in various parts of the United Kingdom, with one or two honourable exceptions it has been used without licence.

Pearlash added to Combined Soap.—With a view to neutralise the spent leys (salts) contained in combined soaps—that is, curd and hydrated soaps combined, as in Blake and Maxwell's process, or other such combinations—Kottula introduces a certain quantity of pearlash, the proportion varying according to the excess of spent leys contained in such combined soap. About 1 cwt. of pearlash to 3 tons of soap is said to be sufficient, though a much larger proportion may be used for some soaps.

Lime Soap, by Lunge's Method.—A flat-bottomed pan is preferred for making this soap, into which is introduced any given quantity of fatty matter. To this is added double the quantity of water, and slaked lime equal to 12 per cent. of the weight of fatty matter. The whole is to be boiled and stirred (with an "agitator" by preference), when an insoluble hard lime soap and a solution of glycerine are produced, when the latter may be drawn off from the bottom of the pan. A certain quantity of water and commercial carbonate of soda (the latter being slightly in excess of the quantity of lime used) are next added, and the boiling and stirring continued, when the hard insoluble lime soap will be decomposed, and a "granulated" carbonate of lime will deposit, leaving a soluble soda soap floating in flakes on the surface of the liquid. If the soda employed does not contain sufficient salt, a sufficient quantity of sea salt is to be added to promote the separation.

"In this way," the inventor says, "it is possible to make a good soap from fatty matters with membranes; or impure oils, without previously extracting the pure fat or oil. When cocoa-nut or palm-oil is saponified by this process, the quantity of lime should be equal to about one-fifth of the weight of the fatty matter. The soap thus prepared is stated to be very soluble, even in salt water, and therefore a tolerably pure carbonated alkali should be used.

CHAPTER XIII.

SAPONIFICATION UNDER PRESSURE.

Bennett and Gibbs's Process.—Mr. Rogers's Process.—New Process of Saponification.—Gluten in Soap.

Bennett and Gibbs's Process.—There have been several attempts to produce saponification by other than the ordinary means, including the "cold process" of Mr. Hawes, before described, in which agitation of the materials performs the preliminary stage of the operation Messrs. Bennett and Gibbs of New York obtained a patent in 1865 for a mechanical process which is said to possess the following advantages: 1. Rapidity of manufacture; 2. Improvement in quality; 3. Increased quantity; 4. Economy in labour; 5. Saving in fuel; 6. The use of cheaper materials; 7. Saponification of all the grease; 8. Saving of the glycerine, which enters into the soap. The following description of the process is given in Dussauce's *Treatise.*

"Their process consists in agitating the saponifiable materials with caustic or carbonated alkalies in solution in water in a closed vessel, while under heat and pressure, in such a manner as to cause a thorough mixing of the fats with the alkaline solution, and producing an instantaneous combination of the fatty acids with the base of the alkaline solution. We suppose a quantity of fatty matter enclosed in a vessel with a solution of carbonate of soda in water, and heat applied to produce a pressure of 220 to 280 lbs. per square inch, and a temperature of 350° to 400° F., a combination between the fatty acids and the soda of the solution will take place only at the upper surface of the solution when in contact with the under surface

of the grease, the heavy ley occupying the lower part of the vessel, and soap will only be produced where the fat and alkali unite.

"If we now agitate in such a manner as to stir together and thoroughly mix the contents of the vessel, the whole will be instantly converted into a homogeneous and even quality of soap. It is advisable to use no more water than is wanted in the soap.

"The inventors use a boiler or cylinder similar to a plain cylinder steam-boiler resting horizontally, and heated in any convenient manner. One or both heads of the cylinder is made so as to be conveniently removable, and is about the full size of the inner diameter of the

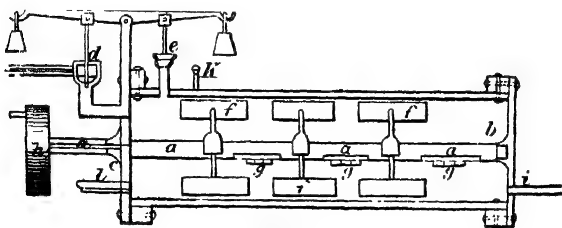


Fig. 21.

cylinder, so as to admit of the insertion of a revolving shaft, *a a a* (Fig. 21), which should be as long as the cylinder itself. The bearings of this shaft should be in the centre of the cylinder, and either or both ends worked through a stuffing-box *c* for the convenience of applying to the pulley *h* power to revolve the shaft. On the shaft are fastened arms *g g* with floats or stirrers *f f*, extending nearly to the sides of the cylinder; the arms, floats, or agitators on one side of the shaft when revolved carrying the fat down into the alkali, while the agitators on the other side carry the alkali up into the fat, thus, while under heat and pressure, thoroughly mixing the whole, and causing the conversion of the whole contents of the vessel instantly into a uniform, even, and good quality of soap.

"At the fire end of the cylinder are placed two safety valves, one *c* on the top of the cylinder, the other *d* on an outlet pipe inserted in the head of the cylinder. They also use a mercury bath K of about four inches in length of gas-pipe, and which is screwed into the boiler or cylinder in any convenient place for the insertion of the thermometer bulb. At the opposite end of the cylinder is an opening *i* for the insertion of a supply pipe; at the fire end is also an opening *l* for the insertion of a second outlet pipe, and which is intended to be used only when it is desired to draw off the whole contents of the vessel. When the machinery is first put in operation, it is necessary to allow some carbonic acid to escape by one of the safety valves, if carbonate of soda is used, in order to prevent undue pressure by the liberation of the carbonic acid when combination of the fatty acids with the alkali takes place. If any of the liquids be allowed to escape before the temperature reaches 325° to 375°, they should be returned to the cylinder.

"The safety valve on the outlet pipe *d* may be so loaded as to allow an escape of soap at a pressure of 250 to 270 lbs., and a quantity of ley and oil may be pumped in at the opposite end, the agitation being kept up, and thus a continual stream of soap is kept up as long as the feeding is continued. The product may then be prepared for market by cooling, moulding (framing) and cutting processes in ordinary use. By this process the soap is made in less than one hour from the time the ingredients are introduced into the boiler, but a uniform and thorough saponification is obtained at the instant that the heat and pressure arrive at the required degree, be the time long or short; if this degree is reached in five minutes, the soap is made."

The proportions employed by the inventors are thus given: carbonate of soda (English) at 48°; water, 100 lbs.; lard, tallow, or oil, 100 lbs.; 27 lbs. of carbonate of soda will, it is said, make a neutral soap for soft water. The product obtained by the above

process is 200 lbs. of soap for every 100 lbs. of grease employed.

The process is stated to be applicable to making any kind of soap, including soft soap, which is prepared with the same rapidity as any other, without requiring the use of so much potash as in the ordinary processes.

Mr. G. W. Rogers's Process.—By another process, namely, that of Mr. G. W. Rogers of Lancaster, N. Y., soap is made under pressure at a *low temperature*, instead of the high temperature adopted in the above and similar systems, by which the inventor states there is a saving of time, inasmuch as the soap can be made in from fifteen to twenty-five minutes, with complete saponification. By this plan, moreover, the materials become *bleached*, thus enabling inferior goods to be employed in the manufacture. The materials are mixed in a tank heated by steam, and the mass thus prepared is run into an iron cylinder capable of holding one or more tons, and subjected to a pressure of about 400 lbs. to the square inch by means of a force-pump driven by steam. The mass is kept in this cylinder until saponification is complete, when it is run into frames. By this system any of the usual combinations of fatty matters may be employed, and the product is said to be both firm and translucent. It should be observed that in both processes given carbonate of soda is used instead of caustic soda, which also renders the employment of common salt unnecessary.

New Process of Saponification.—M. Berghart has patented a process by which animal or vegetable fats or oils are distilled into caustic or carbonated leys of soda or potash. The fatty matter is placed in a jacketed retort, heated by high-pressure steam, or in a retort otherwise heated to a temperature which will volatilise the oil or fat without charring it. When the oil or fat begins to volatilise, air or carbonic acid gas is blown into the retort, which carries over the fatty acids, which are condensed in proper receivers. Atmospheric air alone, or in combination with superheated steam, is preferred in carrying out this part of the process.

The current of air, or steam and air, is sometimes blown into the space above the liquid fatty matter in the retort, and when advisable it is blown direct into the melted fat. The current of air has the effect of carrying over the fatty acids in a more or less finely divided state, when they pass into a chamber, or series of chambers, which are fitted with partitions in such a way that the current, in passing through them, deposits the solid fatty acids in the ordinary way.

When the fatty matters, as printers' grease, for instance, contain *alizarine* or other colouring matters, the fatty acids pass over from the retort, while the alizarine or other colouring matter remains in the retort, and is afterwards treated to separate any remaining fat from the colouring matter, which is thus recovered. It is therefore important, when alizarine or other colour is present, to avoid too high a temperature in the distillation.

In making soap by this process, the vapour of the fatty acids is passed direct into caustic or carbonate leys of soda or potash, the strength of which depends upon the nature of the fatty matter employed. If a slight excess of alkali is used, the ordinary process of "salting" is not required. The fatty acids are blown into the leys until the alkali is nearly or about neutralised. The ley is by preference contained in a closed tank, which communicates directly with the outlet pipe of the retort. If necessary, the fatty acids may be *washed* before being treated with ley, in which case the vapours are allowed to pass into a chamber containing water. The inventor prefers to employ hot air and superheated steam in combination to carry over the fatty acids into the ley, by which the soap becomes boiled during its formation, and thus time is saved in the operation. The air has an important effect in aiding the chemical reaction, apart from its use as a vehicle to carry over the fatty acids. The steam is used principally to prevent the charring of the matters, and in the making of the soap to assist in the boiling of the same. By the employment of the high temperature, the fatty

acids are separated from the glyceryl compounds without the aid of sulphuric acid or of saponification.

Gluten in Soap.—This process, patented by Lorberg, consists in making a solution of gluten in caustic alkali, which is afterwards to be mixed with soap to the extent of about ten per cent. It is said to impart increased emolliency to the soap. The solution of gluten is thus made:—In a solution of caustic alkali (soda or potassa) at about 28° B. as much bran, or gluten derived from any other source, is added as the alkali will take up after digesting for some hours, when a clear homogeneous mass is obtained. This is now strained through a fine sieve or coarse cloth, when it is ready to be added to the soap in the proportion given. It must be borne in mind that nitrogenous matters, such as gluten, are apt to undergo decomposition on treatment with caustic alkali.

CHAPTER XIV.

VARIOUS PROCESSES.

Kurten's Process.—Lumbarton's Process.—Mr. Symons's Disinfecting Soap.—Soaps made from Animal Refuse.—Bernadet's Process.—Villart's Process.—Crevel's Process.—Villacrose's Process.—Cutting Soap.

Kurten's Process.—In this process caustic potash is added to caustic soda in the manufacture of soaps. For making mottled soap, tallow, bone fat, or bleached palm-oil is boiled with ley and converted into a hard soap. The soap is then allowed to remain in the pan from three to six hours, so that the ley may settle. In the meantime a second pan is charged with cocoa-nut oil, and a ley composed of 3 parts caustic soda and 1 part potash added, and when the mass is turning into soap the former soap is added to it, and the two soaps boiled together until sufficiently hard, when the soap thus formed is to be put into frames as usual. It is said that soap thus made has a "beautifully mottled appearance," lathers freely, and has a smooth surface.

In making yellow soap by this process, 2 parts of tallow or palm-oil and 1 part of resin are melted together, and, when nearly cool, for every 100 lbs. of the mixture 90 lbs. of solution of soda and 40 lbs. of solution of caustic potash are added. The mass is then well stirred for five or ten minutes, when it becomes so thick that the ley cannot separate from it; it is then ladled into the frames, and in the course of a day will become solid. The soap is allowed to remain in the frames from three to six days. Now water, or a solution of potash, in the proportion of 10 lbs. to 20 lbs. for every 100 lbs. of soap, is put into the soap-pan, and, when boiling, the soap (previously cut into small pieces) is added to it and allowed to

dissolve, but without boiling. If it is not sufficiently hard when dissolved, brine is to be added until it becomes quite thick. The novelty of this process consists "in the use of caustic potash, and dissolving and warming up the soap a second time without boiling it."

Lumbarton's Process consists in saponifying fatty matters by boiling them with an alkaline mixture composed of carbonate of soda, quicklime, common salt, and alum, the ingredients being mixed in the following proportions:—Sub-carbonate of soda, 10 parts; quicklime, 10 parts; alum, 1 part; common salt, 1 part. These, being mixed with water, are added to the fatty matters, and the whole well boiled, when, it is said, they will become perfectly saponified. The soap produced by this process contains all the glycerine, and the product will be "a hard soap of very fine character; has no disagreeable smell, and can consequently be used for toilet or ordinary washing purposes."

Mr. Symons's Disinfecting Soap consists in adding to ordinary soaps the disinfecting and deodorising substance known as *thymol* or *thymic acid*, which is soluble in water, in solutions of alkalies, &c., forming compounds which are soluble in water. Its advantages over carbolic acid, creosote, &c., are that it has no unpleasant taste or odour, being very aromatic. Its solutions are "strongly antiseptic, and possess disinfecting properties in a higher degree than carbolic acid, and its weaker solutions do not act cauterisingly but coolingly."

Soaps made from Animal Refuse.—Although it is well known that caustic alkalies will saponify animal tissues, membraneous matters, and indeed all parts of animals except the bone, this source of soap-making material has not been much explored in this country. On the Continent, however, some attention has been devoted to this subject, and many processes devised for utilizing slaughterers' offal and butchers' waste as soap material. Some of these processes are given in Dussauce's *Treatise*, from which we make a few extracts:—

"**Bernadet's Process.**—The intestines are deposited in

caustic ley to prevent decomposition until they are to be used. The ley is then heated until entire saponification takes place, which operation is easy, and a very slightly-coloured grey soap is obtained. If required to be whitened, a solution of chloride of soda (see page 112) is poured into the pan, after which common salt is added to produce separation.

"**Villart's Process** has for its object the conversion of animal matters in general into soap, but more especially the residuum of meat, scrapings of tallows (query, suets), intestines, &c. From these two kinds of soap are obtained, the first of a greenish-white colour, not very firm, and having a disagreeable odour; the second is similar to the above, but with the addition of resin and tallow, properly saponified and mixed with the 'animal soap.' The process is divided into four operations:—

"1. *Maceration.* The substances are placed in wooden tubs capable of holding about 300 or 400 lbs., when a ley composed as follows is poured over them:—Lime, 10 parts; soda ash, 12 parts; water, 100 parts. The lime is first slaked and the soda ash dissolved in water, and this is then poured on the lime, with stirring, and the mixture then poured over the animal substances, the whole being allowed to remain in this condition for some time, but with occasional stirring.

"2. *Washing.* When the saponification (by maceration) has been effected, the animal substances are washed in tubs, to remove the lime attached to them, after which they are exposed to the action of the air.

"3. *Solution.* After sufficient exposure to the air, the animal substances are placed in a pan, with a sufficient quantity of water, and for every pound of them add 12 gallons of ley at 4° prepared as follows:—Soda ash, 1 lb.; lime, 1 lb.; water, 6 lbs. This ley marks 15°, and has always succeeded; however, weaker or stronger leys may be used, that is from 20° to 30°, and give good results.

"The animal matters being completely dissolved, the solution is to be poured off from the lime, and the solu-

tion again boiled, adding, during the boiling, 25 gallons of the second ley for every 2 lbs. of substance, and continue to boil until, on cooling, it has the appearance of a firm paste.

"4. *Coction.* The object of this operation is to give the soap a consistency which will render it saleable as a commercial article, for which purpose tallow and resin are added in proportions varying from 2 to 100 per cent. in the second ley above given. Thus, for treating 500 lbs. of the soap first obtained, take: resin, 100 lbs.; tallow, 50 lbs.; liquor, No. 2, 200 lbs. These are to be boiled until perfectly saponified, when the former soap is to be added, little by little, to avoid too much swelling, and the boiling continued until the paste, on cooling, becomes hard, when it is run into frames, and may be cut in about two days after."

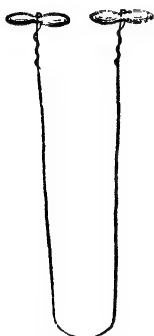
Crevel's Process.—Melt in boiling water the greases, meats, or other parts of animals, press, and keep the residuum; triturate and grind the residuum, macerate it in alkaline liquor for several days; put the macerated substance into a pan, and boil until perfect liquefaction takes place, when it must be allowed to cool. The mass is then to be heated again, and alkali added gradually, care being taken not to employ too strong a ley. When the mixture has acquired the proper alkaline strength the heat is slackened and the mass allowed to cool. From 10 to 15 per cent. of resin should be added to the above, and when saponification is completed the soap is framed as usual.

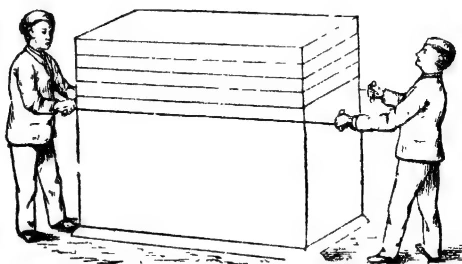
Villacrose's Process.—In this process animal substances are saponified as follows:—Take animal substances, 200 lbs.; caustic soda, 10 lbs.; melted tallow, 40 lbs. The pan is first to be heated, and, when warm, the soda is to be thrown in, the small quantity of water it contains being sufficient to dissolve it. Now, immediately introduce the animal substances and stir well. The heat must be gentle at first, and the temperature gradually raised to 167° F. During the melting the mass must be stirred until it thickens, then add the 40 lbs. of tallow (with a little water if necessary), which soon becomes saponified,

and the operation is complete, and the soap is framed as usual.

Cutting Soap.—When the soap is cold enough to be cut, the bolts are detached from the iron frame (Fig. 2), and the sides and ends are removed and placed aside. The sides and ends of the block of soap are first scraped all over with the scraper, Fig. 22; it is then marked at each corner by means of the gauging stick (Fig. 15). A workman then takes the cutting wire (Fig. 23), and throws the loop over the block of soap, when the wire is taken in hand by a second workman (see drawing, Fig. 24), who fits the wire into

Fig. 22.


Fig. 23.


Fig. 24.

the two upper notches; the first man then pulls the wire by its two wooden handles steadily until the first slab is cut. This top slab is cast aside to be used up with other waste in future batches. When all the soap is cut, the slabs are removed one by one and placed on the barring machine (Fig. 14), to be afterwards cut into bars in the manner before described.

CHAPTER XV.

MANUFACTURE OF SOFT SOAPS.

Preparation of the Potash Ley.—The Fatty Materials Employed.—Scotch Soft Soap.—London "Crown Soap."—Resin in Soft Soaps.—Continental Methods.

ALTHOUGH the production of soft soaps is far less extensive than of those commonly known as hard soaps, still it is an important branch of the manufacture, since these soaps are employed in many useful arts, as for example in the dressing of woollen textile fabrics.

The alkali employed in the manufacture of soft soaps is potash, and it is a characteristic of all soaps made with this alkali that, instead of assuming a hard, solid consistence, as is the case with soaps made from soda, they are always soft, tenacious, and more or less transparent. Moreover, potash soaps always contain a large percentage of water, more in a state of mechanical mixture than in chemical combination; and while 3 parts of fatty matter will generally yield about 5 parts of soda soap, the same proportion of fatty matter, treated with caustic potash ley, will yield from 6 to 7 parts of potash soap.

Potash leys cannot be separated from the soap, as in the ordinary method of purifying soda soaps; therefore the leys employed wholly enter into the composition of the soap. Much care is therefore necessary to avoid introducing too great an excess of the alkali.

Preparation of the Potash Ley.—The pearlash of commerce, or American potash (caustic potash), are ordinarily used for this purpose, and the former is converted into *caustic* potash, by means of fresh lime, in the same way as in preparing soda leys. It is usually the practice to pre-

pare leys of two or three different degrees of strength, the weaker of which is employed in the first operation of *pasting*, or preliminary stage of saponification.

On the Continent potash leys are prepared as follows:—If the potash is in the form of hard lumps, these are first crushed on a hard stone by means of an iron "punner," and if 300 or 400 gallons of ley are required, from 450 to 500 gallons of water are put into an iron-pan, and brought to a boil. The potash is then added, a little at a time, until the whole quantity is dissolved; but care is taken that each portion is dissolved before adding the next, and so on, and the solution of the alkali is accelerated by continual stirring. The boiling is kept up until the solution, while boiling, marks from 20° to 22° B.

To causticise the above solution of carbonate of potash, from 60 to 70 per cent. of fresh lime must be taken, the weight of lime being determined by that of the potash used. The lime must first be slaked with water, as usual, and the hydrate of lime thus formed is to be gradually added to the hot solution of potash; it is, however, considered preferable to make the lime into *milk of lime*, by mixing it with a moderate quantity of water. While the lime is being introduced, the mixture is to be kept well stirred, and the boiling should be continued for several hours, when the fire is withdrawn and the mixture allowed to rest, so that the carbonate of lime may gradually subside. This ley, which is called the *first*, or *strong ley*, should stand at from 20° to 25° B. The clear ley is next run off into an iron tank or cistern, which must be kept closed to prevent the absorption of carbonic acid from the air. When all the clear ley is drawn off, an equal quantity of water is poured on to the lime, and the pan well stirred for a short time, after which it is allowed to rest until the lime has again deposited, when the clear ley, called the *second ley* (marking from 12° to 16° B.) is to be drawn off into a separate tank. A third dose of water is then poured in, and the pan again stirred as before, and after about twelve hours' repose, a *third* ley is obtained at about 6° to 8° B. Further washings of the lime may then

be given, until the lime is perfectly freed from the alkali, and these latter washings may be used in lieu of water in subsequent operations, or instead of using pure water in dissolving fresh quantities of potash when preparing other batches of ley.

Some manufacturers employ variable proportions of soda with their potash leys, by which the soft soaps made with them acquire a firmer consistence than when caustic potash alone is used, besides which an advantage is gained by using a proportion of the cheaper alkali. When this is the case the soda may be dissolved with the potash in the first instance, the proportion of soda to that of potash being from 12 to 20 per cent.; but when a larger proportion than 15 per cent. of soda is used, the resulting soap will not be so transparent as ordinary soft soaps.

The Fatty Materials employed.—These are the animal and vegetable oils. Of the animal oils, those of the whale, seal, and cod are chiefly used; the vegetable oils are olive, hempseed, linseed, rapeseed, coleseed, colza, poppy, &c. Sometimes oleic acid, palm-oil, and small quantities of tallow are also employed in the manufacture, but the latter is only used to give the soap a granular or fig-like appearance.

In making Soft Soap, the selected oils are first put into the pan, and moderate heat applied until the oils have become thoroughly liquefied, when the *third ley*, marking from 6° to 8° B., is run in gradually, with continual stirring, until a perfect combination of the alkali and fatty matters is effected, which is determined by the mass assuming a perfectly homogeneous condition, there being no uncombined oil on the surface or ley at the bottom of the pan. The mixture is then gently brought to a boil, and this is kept up, with stirring, for several hours. As soon as the paste assumes a moderate degree of consistency, additions of the *second* ley, at about 12° to 15° B., are to be made gradually, that is a few gallons at a time every quarter of an hour or so, continuing to do this with constant boiling for a few hours, during which time the added alkali will become gradually absorbed.

During the boiling a considerable amount of fob or foam is formed, but this eventually subsides when the operation is getting near completion, and the mass becomes limpid and transparent. The soap is now to be treated with the *first* or strong ley, at 22° to 25° B., added, as before, in small quantities at a time at short intervals. By continued boiling, and consequent evaporation of the water from the leys, the soap acquires a greater degree of stiffness, and samples should be taken occasionally and examined by pressing between the finger and thumb, in the usual way adopted by soap-boilers; and when the proper consistence is nearly arrived at, small samples should be set aside to cool, in order that their actual condition may be ascertained. If the soap, when tried between the fingers, is stringy, the boiling must be continued, and if it does not possess a sufficiently alkaline taste, an addition of strong ley must be made, and the boiling kept up until the proper consistence is reached.

Some manufacturers introduce a portion only of the oils into the pan in the first instance, and when this quantity has attained a temperature about equal to that of boiling water, the weak ley is added gradually, after which fresh oil is introduced, then more weak ley, and so on, until the entire charge of fatty matter is introduced into the pan, and the boiling is gently kept up until the mass has acquired the proper pasty consistence of the first operation. The additions of stronger leys are then made, as before described, the soap being finished by adding the necessary quantity of the strongest ley.

Boiling.—In boiling soft soaps, great care is taken that the ebullition is very gentle at first, owing to the powerful action exerted by the chemical union of the alkali and fatty matter, during which a considerable frothing occurs If this caution were not observed, the mass would speedily boil over. When examining samples of the soap, if saponification is complete a narrow opaque fringe appears round the outer edge of the sample, when the soap is said to be to *strength*; when this appearance is not present it

is said to want *strength*; or if the opaque fringe first appears and then vanishes, it is said to have *false* strength, and indicates that the saponification is incomplete.

Scotch Soft Soap.—A considerable quantity of soft soap is made in Scotland, and, according to Ure,* the following process is that generally adopted:—"273 gallons of whale or cod oil, and 4 cwt. of tallow, are put into the soap-pan, with 250 gallons of ley from American potash, of such alkaline strength that one gallon contains 6,600 grains of real potash. Heat being applied to the bottom pan, the mixture froths up very much as it approaches the boiling temperature, but is prevented from boiling over by being beaten down on the surface, within the iron curb or crib which surmounts the caldron. Should it soon subside into a doughy-looking paste, we may infer that the ley has been too strong. Its proper consistence is that of a thin glue. We should now introduce about 42 gallons of a stronger ley, equivalent to 8,700 grains of potash per gallon, and after a short interval an additional 42 gallons; and thus successively, till nearly 600 such gallons have been added in the whole. After suitable boiling, to saponify the fats, the proper quality of soap will be obtained, amounting in quantity to 100 firkins of 64 lbs. each from the above quantity of materials. It is generally supposed, and I believe it to be true, from my own numerous experiments upon the subject that it is a more difficult and delicate operation to make a fine soft soap of glassy transparency, interspersed with the figged granulations of stearate of potash, than to make a hard soap of any kind."

There can be no doubt whatever that considerable judgment and caution must be exercised in the boiling of soft soaps, and in determining the exact time when the fire should be drawn or the steam turned off, as the case may be; and when this period has arrived, it is important that the further evaporation of water from the ley should be checked not only by turning off the steam, but, if convenient, by introducing into the soap-copper a sufficient

* "Dictionary of Arts, Manufactures, and Mines."

quantity of *cold soap* to reduce the temperature of the mass.

London "Crown Soap," of the best quality is made from tallow, lard, and olive-oil, and the caustic potash leys are generally employed in two different degrees of strength, the weakest from 8°, and the strongest from 25° to 30° B. The proportions of materials employed for 18 barrels of soap are: tallow and lard 52 lbs. each, and olive-oil 70 gallons. About 400 gallons of ley being prepared, a third of this quantity is first put into the pan, when the tallow and lard are added and the steam turned on; when the fats are melted the olive-oil is run in, and the boiling continued gently, after which the mass is allowed to rest for about two hours, when the steam is again turned on, and about 20 gallons more ley added, and the mass again brought to a boil. Additional quantities of ley are added from time to time until the frothing, at first excessive, begins to moderate, and eventually subsides, and the boiling is continued until samples taken from the pan exhibit the proper consistence. If the sample tried by the trowel is stringy, more ley must be added; but if it appears whitish and clotted, this shows an excess of ley, when a moderate quantity of oil must be added. Towards the end of the operation brisk boiling should be given, and finally moderated; and repeated samples should be taken until the soap is found to be perfected.

A second quality of Crown Soap is made from tallow 286 lbs., sperm-oil 80 gallons, and caustic potash ley 135 gallons. 94 gallons of the ley and the tallow are first put into the pan, and the steam turned on; and when the tallow is melted the oil is to be introduced, after which the steam is to be turned off and the contents of the pan allowed to rest for about two hours. At the end of this time the steam is again turned on, and 19 gallons of ley added, and the whole brought to a boil, the heat being continued until the soap appears to be about half made. 9 gallons of ley are then added, with renewed boiling, and finally the remaining 9 gallons of ley are introduced, and the boiling continued until the soap is complete.

Resin in Soft Soaps.—In making soft soaps resin is sometimes introduced to the extent of 5 or 10 per cent. of the weight of the fatty materials used. The resin is generally introduced into the pan in the form of a fine powder, in the earliest part of the operation, whereby it saponifies with the other ingredients or fatty matters.

Continental Methods.—The method adopted for introducing resin into this soap at Liege is, according to Dussauce, as follows:—"When the soap is nearly done, the quantity of resin required to be added is deposited in a large sheet-iron caldron, pierced with holes like a skimmer. This caldron is then immersed to three-quarters of its height in the boiling soap. In contact with the excess of ley contained in the soap the resin saponifies, and the resinous soap passes through the holes of the caldron and combines intimately with the mass of the soap in the kettle. This arrangement deserves to attract the attention of manufacturers. When the saponification is finished, and when, by a well-managed evaporation, the soap is well boiled, its natural colour is a brownish-yellow. If this colour is required the heat is stopped off, and, after resting a few hours, the soap is drawn off into barrels open at one end. If, on the contrary, the soap is to be green, this shade is given to it by adding a small quantity of indigo. To prepare this colour, macerate for a few hours indigo of good quality in boiling ley. After separating the ley, rub it in a mortar, and pass it through a fine sieve. To colour the soap, add a certain quantity of the paste to the soap, and incorporate by good stirring."

In Belgium and Holland soft soaps are made from vegetable oils, with, sometimes, the addition of oleic acid, tallow, or other animal fats. The following formula is given for a soft soap of good quality:—Linseed-oil, 600 lbs.; coleseed-oil, 800 lbs.; oleic acid, 200 lbs. These materials are first put into the pan and heated gently, and, when in a liquid state, 75 gallons of caustic potash ley at 6° to 8° B. are added gradually, with continual stirring. The pan is then brought to a boil, and

this is kept up for several hours. A stronger ley, marking from 12° to 15° B., is then introduced a little at a time, care being taken to avoid the boiling over of the pan when the chemical action is at its most vigorous point. As soon as the usual frothing subsides, the soap will become clear and of a glutinous consistence, when doses of from 10 to 12 gallons of ley, marking 22° to 25° B., must be added at moderate intervals, the boiling being continued until the saponification is complete. The boiling is then to be kept up until, by the usual sample tests, the soap is known to be finished.

Ordinary English and Scotch soft soaps, being made chiefly from fish oils, are of a brown colour, while the Continental soaps, which are mostly made from vegetable oils, are frequently of a green colour. *Savon vert* is the title given to these soaps, whether the green colour is derived from materials used in the manufacture, or from the artificial admixture of indigo, as before described.

CHAPTER XVI.

MANUFACTURE OF SOFT SOAPS—(continued).

Belgian Soap.—Russian Soft Soap.—Gentele's Process.—Jacobson's Process.—Soap for Silks and Printed Goods.—Fulling Soap.—M. Loch's Soft Soap.

Belgian Soap.—In Belgium, a half-hard soap is largely produced for the use of cloth manufacturers, and is employed in scouring woollen textile fabrics. This soap contains an excess of alkali (potash), an essential feature in soaps employed for this purpose. The caustic ley is used at three different degrees of strength, namely, 18°, 20°, and 30° Baumé, and these represent the *first, second,* and *third* leys used in the preparation of this soap. The fatty materials are divided into three groups, as follows:—

No. I.		No. II.		No. III.	
Tallow.. ..	380 lbs.	Tallow.. ..	225 lbs.	Tallow	150 lbs.
Colza-oil ..	70 ,,	Tallow-oil ..	225 ,,	Bleached palm-oil	300 ,,
Cocoa-nut oil	150 ,,	Cocoa-nut oil	150 ,,	Cocoa-nut oil..	150 ,,
	600 ,,		600 ,,		600 ,,

The quantity of ley requisite for 600 lbs. of fatty materials, according to either formula, will be from 750 to 775 lbs. One third of this quantity must mark 18°, another third 24°, and the remainder 30° B. The two first-named fatty matters are put into the pan with the weakest ley, and these are boiled together, after which the second strength of ley is added gradually, followed by the strongest ley. The entire quantity of ley should be introduced within two hours, and the boiling is kept up until the paste separates from the ley when tried by the shovel

in the usual way. The soap is then allowed to repose, when the deposited ley is to be withdrawn, and the cocoa-nut oil in a melted state is then introduced, and a sufficient quantity of ley added to render the soap caustic. Boiling must be continued until the soap is sufficiently firm, and when this condition is reached the fire is withdrawn and the soap allowed to cool down, after which it is to be transferred to shallow frames. By the separation of the ley which takes place in the above process, the saline impurities contained in the potash are removed. About 12 cwt. of soap should result from the proportions given.

Russian Soft Soap.—In Russia a soft soap is made from a ley composed of three parts Russian or American potash, and one part pearlash (a carbonate of potash), the solution or ley being brought to 10° B. One half of the ley is added to the oils or fatty matters in the pan, and while these are undergoing the process of boiling the remainder of the ley is allowed to flow slowly into the pan from a cistern situated above that vessel. After the necessary boiling, and when the soap has acquired the proper consistence, the fire is withdrawn and the soap left in the pan to cool.

Gentele's Process.—A process was suggested by M. Gentele for making soft soap with one-fifth part of soda mixed with the potash ley. By preference, crystals of soda are used; and it is important that the leys should be free from chloride of sodium or other saline impurities. The fatty materials recommended for this process are: red oil, 100 lbs.; tallow, 40 lbs.; hempseed-oil, 3,750 lbs.

Jacobson's Process.—The inventor prepares a very useful household soap by mixing oleic acid with soda or potash ley in the following proportions:—

Distilled oleine	2 gallons.
Ley	1 gallon.
Hot water	5 gallons.

While pouring the hot water into the pan (in which the oleine is first placed) constant stirring is kept up, and the ley then added gradually with continued agitation, until

the mass has assumed the appearance of a thick yellowish paste without granules. After twenty-four hours' rest, the soap is perfectly white and ready for use. The advantages claimed for this process are the rapidity and ease with which the soap is made and its extreme simplicity. The inventor says that adulteration is impossible, since other substances, if introduced, would interfere with the process of saponification. The economy of the process is also stated to be an important feature in this method of preparing a soft soap.

Soap for Silks and Printed Goods.—The late Professor Crace-Calvert, of Manchester, to whose indefatigable exertions in industrial chemistry manufacturers were indebted for much valuable information, suggested the following formulæ for soaps to produce the highest brightening effect upon the various shades of colour:—

For Madder Purples.

Fatty matter	60·4
Soda	5·6
Water	34·0
	100·0

For Madder Pinks.

Fatty matter	59·23
Soda	6·77
Water	34·00
	100·00

For bleaching raw silk, white olive-oil soap is used on the Continent.

Oleic acid, saponified by potash ley, is a very suitable fatty material for making soft soap. The first potash ley should have a strength equal to about 20° B., and the soap may be finished with a stronger ley—from 25° to 28°.

Fulling Soap.—The soap used by cloth manufacturers for fulling or cleansing woollen cloth requires to be rather more alkaline than ordinary household soaps, but at the same time it must not contain such an excess of alkali as to affect injuriously the more delicate colours of the dyed wool. Some manufacturers employ a mixture of oleic acid

(brown oil) soap, and mottled soap, in the proportion of nine parts of the former to six parts of the latter.

M. Loch's Soft Soap.—In addition to the usual fatty matters the inventor introduces borax, binoxalate of potash (salt of sorrel), soapwort, pipeclay, sal ammoniac, and turpentine, whereby he professes to produce a cheap and economical soap, "particularly applicable for manufacturers of woollen goods, cotton-mills, bleaching and scouring works, &c." To make 220 lbs. of the soap, 9 lbs. of soapwort (*Saponaria officinalis*) are boiled in 22 gallons of water, which is then passed through a sieve. In 13 gallons of this decoction, while hot, are dissolved 62 lbs. of slaked lime, and in the remaining 9 gallons, also while hot, are dissolved 9 lbs. of borax, 26 lbs. of potash, and 2·2 lbs. of binoxalate of potash. This solution is then poured slowly into the first-named decoction, and the mixture is boiled until the ley is found to be sufficiently caustic. The whole is again passed through a sieve, and then boiled gently with 66 lbs. of fixed oils until thick bubbles rise, and the soap assumes the required flocculent condition; 13 lbs. of resin and 13 lbs. of Iceland moss (previously boiled down and passed through a sieve). This mixture is then allowed to boil slowly until thick bubbles rise and all the ingredients have thoroughly combined. It is then allowed to cool, and finally, at the time of packing for transport, 6·6 lbs. of sal ammoniac and 2·2 lbs. of pure turpentine are mixed up with 220 lbs. of the soap. The packing for transport is by preference effected in well-closed wooden cases, which are coated well inside and outside with silicate of soda, and a sheet of vegetable parchment should be placed over the soap before putting on the lid.

The use of sal ammoniac and of binoxalate of potash in this process is not easily intelligible. Again, Panama bark (*Quillaza saponaria*) is far preferable to soapwort, but it is generally used, not in combination with soap, but as a separate agent. It is largely used in getting up the finest quality of white worsted goods.

CHAPTER XVII.

MANUFACTURE OF TOILET OR FANCY SOAPS.

Apparatus for Re-melting the Soap.—Machine for Slicing the Soap.—Re-melting the Soap.—Mixing Colouring Matters and Perfumes.—Cutting the Soap.—Stamping the Soap.

ALTHOUGH the manufacture of toilet soaps occasionally forms part of the soap-makers' business, it is more generally carried on as a separate trade, or is attached to the business of the perfumer. In either of the latter cases, the soap from which the toilet soaps are produced is generally furnished by the larger soap-makers, and is re-melted, perfumed, and tinted by the fancy soap-maker.

Before explaining the system of manufacture, it will be necessary to direct attention to the apparatus employed and the methods of applying them, and in doing so, we may as well show how the manufacture can be conducted upon a moderate scale.

Apparatus for Re-melting the Soap.—The pans for this purpose may be made from wrought copper, fitted into an iron steam-tight jacket, the size being regulated according to the probable requirements of the manufacturer. These pans should be capable of containing from 2½ cwt. to half a ton of melted soap. A simple form of apparatus, which the author has employed for this and other purposes, is shown in the woodcut (Fig. 25). It has the advantage of being cheap in construction and economical in use.

Several sound casks (rum puncheons answer admirably), having their heads removed, are to be well coopered, so as to be water-tight. Into each of these a galvanized-

iron copper or pan, A, is placed, and is supported by its flange upon the upper edge of the cask; but, in order to prevent the escape of steam, by which these pans are to be heated, the flange is to be well luted with cement. This may readily be done by first spreading with a trowel a stiff paste of Portland cement inside the rim of the tub, and flush with its extreme edge. When this has set quite hard, a somewhat thinner paste of cement is spread upon the former layer, and the pan then carefully lowered into its place, when it will become imbedded in the

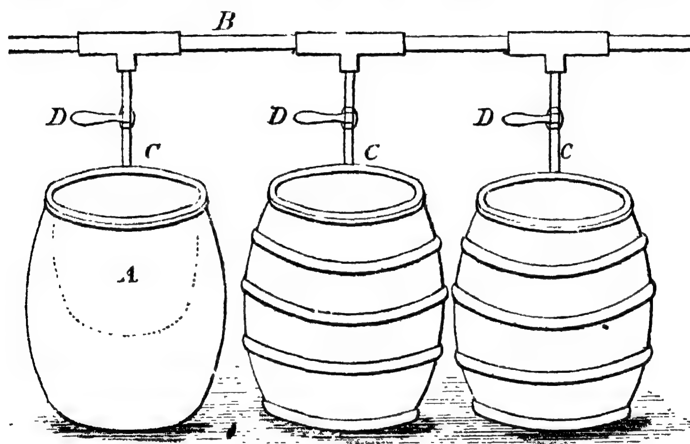


Fig 25.

cement, which should then be trimmed neatly with the trowel. In a day or two the luting will be sufficiently hard to enable the vessels to be used. A wooden cover is provided for each pan.

The horizontal iron pipe, B, conducts the steam to the vertical pipes C C C, each of which is furnished with a shut-off cock, D D D, and the ends of these pipes are bent so as to allow them to enter the casks through holes drilled about half-way down, and which are carefully secured in their position by calking with tow, or by any other convenient means. To allow the escape of con-

densed steam, and as a vent for exhausted steam, a half-inch hole is drilled at the bottom of each cask, immediately above the iron hoop; and these must always be kept perfectly free, otherwise the pans would be liable to become lifted by the pressure of the steam. When required for use, the taps are first opened full, in order to allow any water which may have remained in the pipes to flow into the tubs, and from thence to escape through the perforations at the bottom. The taps should then be half turned, and the steam moderately turned on at first, to allow the condensed water to escape freely. After a while the taps may be turned nearly full on, when the steam will issue from the water-holes at the lower part of the casks. The pans, A, will hold about 2 cwt. of soap each.

A convenient form of steam-jacket pan is given in Fig. 26. The dotted lines at A show the position of the

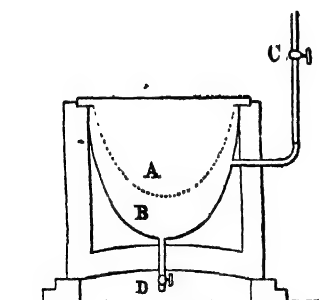
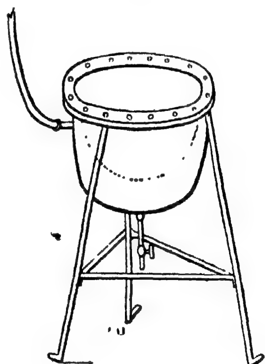


Fig. 26.


Fig. 27.

pan in the jacket B. The supply-pipe, C, is furnished with a stop-cock. D is an exit-pipe for the escape of condensed water and waste steam. For small experimental operations the copper jacket-pan represented in Fig. 27 is a very convenient vessel.

Machine for Slicing the Soap.—Previous to re-melting the soap, which is in the form of bars about

14 inches long by $2\frac{1}{2}$ inches square, it is necessary to cut the soap into thin slices, by which the operation of melting is considerably hastened. There are many forms of apparatus for this purpose, one of the simplest being represented in Fig. 28. This consists of a wooden bench supported by strong framework, and furnished with a blade of steel fixed angularly in a slit cut diagonally out of the flat surface of the bench. The blade is adjusted so as to project a little distance above the board, and the arrangement is like that of an inverted carpenter's plane. Beneath the cutter or planing-machine is a broad and deep drawer for receiving the shavings of soap. When

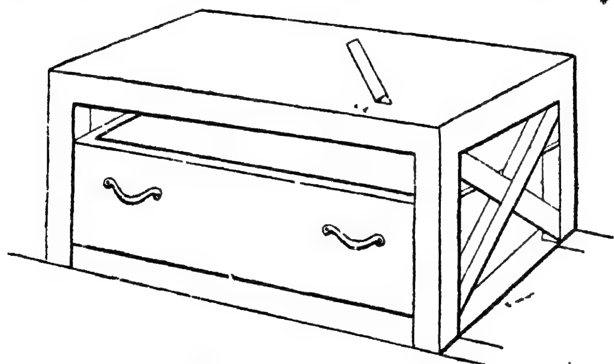


Fig. 28.

in use, a bar of soap is pushed lengthwise towards the blade and beyond it, when a thin slice is cut off and falls through the slit into the drawer beneath. By this simple contrivance, and by a quick workman, soap bars may be cut into thin shavings with sufficient rapidity to feed several such melting-pans as those described.

For more extensive operations, the machine shown in Fig. 29 is much used. This consists of a cutter, *a*, attached to the centre of which is an iron shaft, at one end of which is a handle, *c*, to set the machine in motion. The machine is fixed on a wooden frame, *d d*. At *e* is an inclined plane of wood. upon which the soap, *f*, is placed to

be cut into shavings. A wooden box, *g*, receives the shavings as they fall from the machine. The bar or slab of soap, being placed on the inclined plane, *e*, is allowed to touch the cutter; the handle being now turned, the first blade removes a shaving, and is immediately followed by the second blade, and so on until the entire bar is cut, when it is replaced by another, and so quick is the operation, that in an hour two cwt. of soap may be reduced to shavings by this useful machine.

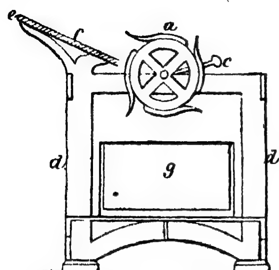


Fig. 29.

Re-melting the Soap.—The soap to be re-melted for conversion into toilet soap should be pure "unliquored" soap, and of recent manufacture, otherwise those surfaces which may have become hardened by long keeping will be troublesome to liquefy. The bars of soap are first reduced to thin slices by the planing-machine (Fig. 28), and a few of these are first placed round the interior of the pan and in contact with it, when the steam is to be turned on, and, after a short time, the soap will begin to melt where it is in contact with the pan. To prevent the soap from becoming dry on the unmelted surfaces, it is a good plan to sprinkle it with water. After putting in the first few slices of soap, the wooden covers should be placed over the pans, and these should not be raised until sufficient time has been allowed for the pans to become well heated. If now, on raising the lid, the soap appears to have fairly commenced to melt, a few more slices of soap may be introduced, and the pan again covered. After a short time fresh quantities of soap may be put into the pan gradually, and care must be taken to avoid adding an excess of the cold soap, otherwise it will, by chilling the melted soap, form a conglomerate mass which will not readily liquefy. If these precautions are observed there will be no difficulty in the re-melting. As fast as the soap melts it will sink to the bottom of the pan; and, in order

to assist the mingling of the melting soap with that which is already liquefied, gentle stirring may be applied, and fresh batches of sliced soap added gradually, until the pan is sufficiently full. The heat must be kept up, with occasional stirring with a small wooden crutch, until the mass is perfectly homogeneous and free from unmelted lumps.

Since toilet soaps are required to be somewhat firmer and harder than ordinary household soaps, a certain amount of evaporation of their combined water must be allowed to take place during the re-melting; but this must not be carried too far, otherwise the soap will be liable to crack during the subsequent pressing or stamping operations. Again, it will be necessary to evaporate a portion of the combined water to allow for the addition of the essential oils or perfumes which are to be blended with it.

When dry colouring matters, as vermilion, yellow-ochre, red-lead, and various metallic oxides have to be mixed with the melted soap, care must be taken not to allow the paste to become too stiff, otherwise, when these are incorporated with the mass, it may become unmanageable.

Mixing Colouring Matters and Perfumes.—The proportions of colouring matter and essential oils to be added to the melted soap being weighed and measured, may be worked up together with a spatula, and the mixture then poured into the soap and thoroughly incorporated by continual crutching or stirring. Or the colouring matter may be added, a little at a time, to a portion of the melted soap dipped out of the bulk by a small ladle (Fig. 30), and when this is well mixed it should be poured into the pan and stirred in, the remainder of the colour being introduced in the same way. By this method the colouring matters and essential oils may be very perfectly and uniformly blended with the soap paste. When perfumes are used without colouring matters, they



Fig. 30.

should be slowly poured into the pan, with stirring, until the requisite proportion has been added. The soap being perfumed and coloured, small samples should be taken to determine if it be of the proper consistence to set hard and firm without being brittle. It is now ready for the frames, which, for scented soaps, are much smaller than those employed for household soaps.

The condition of the soap when ready for the frames is that of a thick pasty mass, and must be transferred to the frames by means of the short-handled ladle (Fig. 30), or swimmer (Fig. 12); and when the frame is full the soap should be pressed or patted down, so as to prevent any hollows or cavities being formed through the irregular distribution of the soap in the frame. The soap should also be well covered with cloths, so that the cooling may be very gradual.

Cutting the Soap.—When the soap is sufficiently cold it is cut into slabs and bars proportionate to the size required for the tablets, which generally run eight, six, four, or two to the pound. The bars are next divided into cakes or blocks, the width of which is regulated according to the size and weight of the tablets.

Stamping the Soap.—As the tablets of toilet soaps are generally of an oblong form, with rounded corners, the cakes which have been cut from the bars require to be *trimmed* before they undergo the process of stamping. This is generally done as follows: A workman, taking a cake in his hand, passes each sharp edge of the cake over the blade of a planing-machine, such as is shown in Fig. 28, the blade of the machine being so adjusted as to remove only a small portion from the edges. The corners are next trimmed with a knife, and each cake is weighed from time to time during the trimming, until it approaches the required weight for the tablet.

The cakes thus prepared are next put aside to dry, or are placed in a drying-room, so that the surface may be free from stickiness before they are stamped. The cakes, after being trimmed and dried as described, are first moulded in a lever press (Fig. 31), which gives them the

desired form. A A is a strong wooden table, to which the press is firmly attached by bolts and screws; B is a cast-iron pillar, to which the lever C and the piston D (to which the upper half of the mould is connected) are attached; E is the lower half of the mould. In applying this press the workman places the cake of soap upon the lower half-mould, and then brings the lever down with considerable force, and then jerks it upwards, so as to separate the two halves of the mould. If necessary, he gives the cake several blows, after which he removes it and replaces it by another cake.

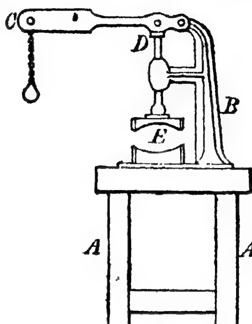


Fig. 31.

The cakes thus stamped are again set aside until their surface is perfectly dry, after which they are slightly scraped all over, and a little alcohol is sometimes rubbed over them to impart brilliancy to their surface.

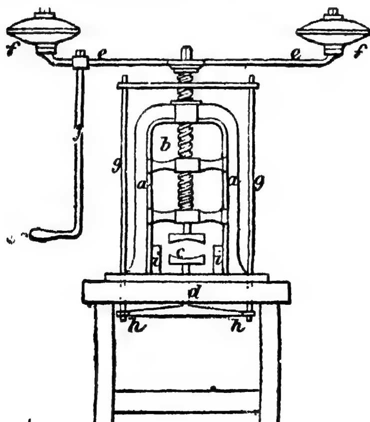


Fig. 32.

The cakes are finally stamped in a second press, which may be of the form given in Fig. 32, which is called a "fly"

or screw press. This useful press is, like the former, supported upon a strong wooden table, which latter must be secured to the floor by bolts, or screws. *a a* represents the frame of the press; *b* the screw, furnished at its lower end with a socket, into which the upper half-mould is secured by a screw; *c* is the lower half-mould, and which is connected to the movable rod *d*. The fly, *e e*, is surmounted by two heavy balls, *f f*. The upright wrought-iron rods, *g g*, are adapted by screws to the horizontal bar below, *h h*. These rods pass beneath the cast-iron or brass matrix, *i i*, and raise the movable rod *d* after each stroke of the press, by which means the stamped tablet is set free, and, being removed, is replaced by another. In the upper half-mould is fixed, by means of a screw, the engraved stamp which is to impress the soap. After stamping the tablets they are carefully trimmed at the edges, and are then ready for wrapping up.

CHAPTER XVIII.

MANUFACTURE OF TOILET SOAPS—(continued.)

Rose Soap. — Orange-flower Soap. — Cinnamon Soap. — Musk Soap. —Bitter Almond Soap. — Windsor Soap. — Brown Windsor Soap. —Violet Windsor Soap.—Savon au Bouquet.—Savon à la Cannelle. —Almond-oil Soap.—Marshmallow Soap.—Vanilla Soap.—Benzoin Soap.

Rose Soap, or **Savon à la Rose,** may be made from either of the following formulæ, the soap being previously well melted, as before described :—

I.

White curd soap, made from best tallow	60 lbs.
Olive-oil soap	40 ,,
Vermilion in fine powder	3 ozs.

The vermilion is to be first well mixed with the soap, great care being taken to ensure *perfect* incorporation. The steam is then to be turned off, and when the soap has cooled a little the following perfumes are to be added in about the proportions given :—

Essential oil of rose	6 ozs.
,, oils of cinnamon and cloves, of each	2 ,,
,, oil of bergamot	5 ,,

Soap prepared from the above formula has a delicate rose colour, is very fragrant and emollient, and is indeed one of the finest of toilet soaps.

II.

White curd soap	100 lbs.
Vermilion	10 ozs.
Oil of rose	15 ,,
,, bergamot	5 ,,
,, neroli	2½ ,,
Oils of cloves and cinnamon, of each	5 ,,

Orange-flower Soap.

White curd soap	60 lbs.
Palm-oil soap	40 ,,

Colour with

Yellow-green pigment	16 ozs.
Minium (red-lead)	2½ ,,

Perfume with

Oil of Portugal	15 ozs.
,, ambergris	15 ,,

Cinnamon Soap.

White curd soap	60 lbs.
Palm-oil soap	40 ,,

Colour with 2 lbs. of yellow ochre and perfume with

Oil of cinnamon	14 ozs.
,, sassafras	2½ ,,
,, bergamot	2½ ,,

Musk Soap.

White curd soap	60 lbs.
Palm-oil soap	40 ,,

Colour with

Brown ochre, or Spanish brown	8 ozs.

Perfume with

Oils of musk and bergamot, of each	7 ozs.
Powder of cloves, pale roses, and gilliflower, of each	9 ,,

Bitter Almond Soap, or **Savon d'Amandes Amères.**

White curd soap	100 lbs.
Oil of bitter almonds	20 ozs.

Windsor Soap.—This famous toilet soap, as prepared in London, is generally made from tallow nine parts and olive-oil one part, and is perfumed (for every 1,000 lbs. of the paste) with

Oil of caraway	6 lbs.
Oils of lavender and rosemary, of each	1½ lb.

Or, for each 100 lbs. of soap,

Oil of caraway	5 ozs.
,, bergamot	10 ,,
,, cloves	2½ ,,
,, thyme	5 ,,

Or, for the same quantity of soap,

Oil of caraway	10 ozs.
,, bergamot	5 ,,
Oils of lavender and rosemary, of each	2½ ,,

Brown Windsor Soap is prepared as above, and coloured either with burnt sugar (caramel) or *umber*.

In making this soap some perfumers have adopted a system of making what is called an *instantaneous soap*. This consists in saponifying the fatty matter, which is generally a mixture of hog's lard and tallow, with strong ley. Twenty parts of the fatty matters are taken, to which is added ten parts by weight of caustic soda ley at 36° B., and these being put into a small jacket-pan, steam heat is applied until the mass assumes a fluid condition, when five parts more ley are introduced, with constant stirring for an hour or so. At the end of this time an additional five parts of ley are given, and the agitation continued, the heat of the mass not being allowed to exceed 150° F. When the ley has deposited, and the paste become perfectly homogeneous and of the proper consistence, it is transferred to another pan, and the perfumes are then added, after which the soap is ladled into the frame. In about twenty-four hours or less the soap will be cool enough to cut. It must not be allowed to remain until quite cold, or it will become too hard for cutting. These instantaneous soaps are best made direct from the fatty acids, with carbonate of soda, as recommended by Mr. Morfit.

Windsor Soap is also made from lard in the same way as olive-oil soap, and the perfumes—oils of caraway, lavender, and rosemary—are added so soon as the soap has acquired the proper degree of firmness.

Violet Windsor Soap is made from lard, 50 parts; palm-oil, 33 parts; and spermaceti, 17 parts; and the perfume employed is essence of Portugal, to which a little oil of cloves is added. The well-known violet odour of the palm-oil, modified by the perfumes, gives an agreeable fragrance to the soap.

Powdered cassia is a useful substance for giving an agreeable brown colour to toilet soap, but it must be added

a little at a time, and well crutched or stirred into the melted soap.

Savon au Bouquet.—This soap is prepared from the following:—

White curd soap	60 lbs.
Olive-oil soap	40 ,,

Perfume with

Oil of bergamot	13 ozs.
,, neroli	$1\frac{1}{2}$ oz.
Oils of clove, sassafras, and thyme, of each	$1\frac{1}{4}$,,

Colour with

Brown ochre	22 lbs

Savon à la Cannelle. (Cinnamon Soap.)

White curd soap	60 lbs.
Palm-oil soap	4 ,,

Colour the paste with

Yellow ochre	2 lbs.

And perfume with

Oil of cinnamon	14 ozs.
,, sassafras and bergamot, of each	25 ,,

Almond-oil Soap is, according to Dussauce, prepared in France as follows, and since it is sold at a high price, the materials must be of the best and purest quality. "The oil of sweet almonds must be perfectly fresh, and the carbonate of soda chemically pure. The soda is dissolved in water, adding to it one-third of its weight of slacked lime; stir from time to time, and after several hours, filter; concentrate the ley by evaporation until it marks 36° B.; then take 12 parts for 25 parts of oil, introduce the ley into a jar, and gradually incorporate the oil, being careful to stir the mixture until it has the appearance of a soft grease. In two or three days its consistency is such as that it can be run into china moulds, if placed in a room the temperature of which is from 71° to 107°. In about one month it can be taken from the moulds. The temperature of the ley must be from 40° to 59° (104° to 140° Fahr.), but the soap may be prepared more rapidly by placing the mixture on warm ashes, and

adding a little warm water to the ley, so as to prevent its concentration. This soap is very white, with a sweet taste and odour. It becomes very hard."

Marshmallow Soap.

White curd soap and palm-oil soap, of each ...... 40 lbs.

Colour with

Yellow ochre	4 ozs.
Orange mineral	4 ,,
Gamboge	$1\frac{1}{4}$ oz

Perfume with

Oil of lavender	10 ozs.
,, lemon	2 ,,
,, neroli	2 ,,
,, verbena	10 ,,
,, mint	3 ,,

Or, the following :—

Oil of Portugal	6 ozs.
,, thyme	4 ,,
,, lavender	$1\frac{1}{4}$ oz.
,, cinnamon	2 ozs.
,, cloves	3 ,,

This soap may be coloured rose with vermilion, or be left as a white soap if desired.

Vanilla Soap.

White curd soap	40 lbs.
Tincture of vanilla	2 ,,
Oil of rose	$2\frac{1}{2}$ drms.

Colour with

Burnt sienna	7 ozs.

Benzoin Soap.

White curd soap	40 lbs.
Tincture of benzoin	54 ozs.

The soap must be in the form of a very stiff paste, otherwise the tincture of benzoin will render it rather soft. Brown ochre may be used as the colouring agent.

CHAPTER XIX.

MANUFACTURE OF TOILET SOAPS—(continued).

French System of making Toilet Soaps.—Formulæ for French Toilet Soaps.—Savon de Guimauve.—Savon aux Fleurs d'Italie.—Savon de Crimée.—Savon de Palme.—Violet Soap.—Vanilla Soap.—Rose-leaf Soap.—Savon à la Maréchale.—Lettuce Soap.—Ambergris Soap.—Elder-flower Soap.—Lemon Soap.—Orange Soap.—Glycerine Soap.—Savonnettes or Washballs.—Violet Washballs.—Honey Savonnettes.—Savonnettes of Sweet Herbs.—Savonnettes of Camphor.—Savonnettes of Neroli.—Savonnettes à la Vanille.—Marbled Savonnettes.—Savonnettes au Miel.—Floating Savonnettes.—Sand Balls.

French System of Making Toilet Soaps.—Instead of preparing toilet soaps from re-melted soap, as before described, a system is adopted on the Continent by which these soaps are made by a series of mechanical operations which we will endeavour to describe as briefly as possible. The various operations are arranged under the following heads:—1. Cutting the soap into shavings. 2. Mixing the essential oils and colours with the soap. 3. Grinding the soap. 4. Pounding the soap in a mortar. 5. Balling the soap. 6. Pressing. 7. Stamping.

Cutting the soap into shavings is performed by a machine such as is shown in Fig. 29, and the shavings are placed in a lead-lined wooden box. The proper proportion of essential oils and colouring matter (except when the soap is required to be white) are first mixed in a separate vessel, with a little alcohol, and the mixture is then added gradually to the shavings, with continual stirring. The perfumed shavings are next placed in a grinding-machine, through which they are allowed to pass several times, until a perfectly homogeneous paste is formed.

The soap is next pounded in a marble mortar, by means of a wooden pestle, the object of which is to convert the soap into a uniform mass. Only a few pounds (about ten or twelve) of soap are pounded at a time, lest it should become too dry for the subsequent operation of *balling*, which is performed somewhat as follows:—The soap is placed on one end of a table on which is a marble slab, and in order that an allowance may be made for the reduction of weight which the soap has to undergo in the process of drying, the balls or cakes of soap are made about 25 per cent. heavier than the finished tablets. The directions for making the soap into cakes of the proper size, weight, and form for the pressing and stamping machines are thus given by Dussance:—

"Weigh as many pieces of 4½ ounces as you want of cakes of 3½ ounces; knead with the hands each little mass of soap, so as to form a ball, which is made round on the marble slab. For this purpose, the ball being on the marble, give it a rotary movement with the right hand. The ball being obtained, leave it on the marble, and give it a cylindrical shape by rolling it with the flat of the hand. This cylinder must not be larger than the model (mould?). Nevertheless, as the cylindrical shape is not that which the soap ought to have, strike the cylinder on all its sides on the marble to square it—that is, to form an oblong square—and round the angles by striking them gently on the marble. If any unforeseen circumstance requires a suspension of the work, cover the pounded soap with a damp cloth and keep it in a cool place. If the soap is too dry, it will be difficult to work well. Once begun, it must be worked quickly and without interruption.

"The small cakes being shaped as indicated, dispose them on trays or frames of white wood, traversed in their length by small rods of wood, in such a way that each frame presents as many empty spaces as full ones. These frames have a length of twenty-seven inches, by eighteen wide; they are arranged on shelves, at a distance of five or six inches from each other."

In arranging the soap cakes as above, a space of about

half-an-inch is allowed between each, so that the air may circulate round them, and thus facilitate their drying on the surface. It is important that the drying should be as rapid as possible. In about a week the surface of the cakes will have become hardened, and ready for pressing. This is done by means of a lever press, Fig. 31, which merely gives to these cakes the preliminary form of the mould. To apply the press, one of the cakes is placed on the lower half of the mould, and the lever is then forced downwards and then raised, when the cake is removed and another substituted for it, and so on, until all the cakes have been struck. The edges of the cakes are then trimmed, after which they are again set aside to dry, and when sufficiently so they are removed from the drying-room, and the hardened skin which has formed upon the surface is carefully removed by means of a sharp knife, with which the cakes are dexterously scraped by the workman. It is said that a good workman can scrape forty dozen of cakes in a day.

When the cakes have been scraped they are moistened with alcohol, to improve the smoothness of their surface. To accomplish this, the fingers of the right hand are dipped in alcohol, and this is spread quickly over the cake, which is then rolled in both hands, by which it becomes moistened all over in a few moments. The cakes are again dried for about twenty-four hours, after which they are ready for the final stamping, which is effected in the fly or screw press, by which an active man can mould 1,500 cakes of soap per day.

In the above process there is a loss of about 14 or 15 per cent. of water during the several drying operations, but this is allowed for in the operation of balling, in which the cakes are made heavier than the resulting finished soap is required to be. The scrapings of the cakes are afterwards worked up in future batches of the same kind of soap.

Formulæ for French Toilet Soaps.—The following are some of the formulæ for toilet soaps adopted by the French makers :—

Savon de Guimauve. (Marshmallow Soap.)

White tallow soap .... 10 lbs.
Palm-oil soap .... 10 ,,

Colour with

Yellow ochre .... 1 oz.
Orange mineral .... 1 ,,
Gamboge .... 5 drms.

Perfume with

Oil of lavender .... 1½ oz.
,, mint .... ½ ,,
,, caraway .... ½ ,,
,, lemon .... 5 drms.
Oils of rosemary and thyme, of each .... 2½ ,,

Savon aux Fleurs d'Italie.

White tallow soap .... 20 lbs.

Perfume with

Oil of citronella .... 1½ oz.
,, geranium .... ½ ,,
,, verbena .... 1 ,,
,, mint .... 2½ drms

Colour with

Brown ochre .... 2½ ozs.

Savon de Crimée.

White curd soap .... 16 lbs.
Palm soap........................ 4 ,,

Colour with

Vermilion .... 2½ drms.
Brown ochre .... 1 oz.
Ivory black .... ½ ,,

Perfume with

Oils of thyme, mint, and rosemary, of each .... 1 oz.
Oil of lavender .... 2½ drms.
,, cloves .... 1¼ drm.
Tincture of benzoin .... 1½ oz.

Savon de Palme.

Palm soap........................ 10 lbs.
Half-palm soap .... 10 ,,

Perfume with

Oil of bergamot .... 2 ozs.
,, cloves .... ½ oz.
Oils of cinnamon and lavender, of each .... 1 ,,

Violet Soap. (Yellow.)

Yellow cocoa-nut oil	20 lbs.
Palm-oil	20 „
Tallow	10 „
Soda ley at 36° B.	26 „
Powdered orris-root	4 „

To which are added the following perfumes:—

Oil of lemon	4 ozs.
„ rhodium	2 „
„ thyme	2 „
Tincture of musk	4 „

Colour with cadmium yellow.

√**Vanilla Soap.**

Lard, with vanilla	30 lbs.
Cocoa-butter	10 „
Palm-oil	10 „
Caustic ley, 36° B.	26 „
Wax	2 „
Starch	2 „

Perfume with

Tincture of vanilla	4 ozs
„ musk	2 „
„ ambergris	2 „
Oil of rose	½ oz.

Lard with vanilla is prepared by adding the vanilla to the lard (1 oz. to the lb.), keeping it at a moderate heat for some days, then straining, &c.

Rose-Leaf Soap.

Rose pomade	20 lbs.
Lard	20 „
Cocoa-nut oil	10 „
White wax	2 „
Soda ley, 36° B.	20 „
Potash ley, 30° B.	12 „
Gum tragacanth	8 „

Perfume with

Oil of roses	2 ozs.
„ geranium	2 „
„ rhodium	1 oz.
„ bergamot	2 ozs.
„ cinnamon (Ceylon)	½ oz.

Colour with aniline fast red, a light pink.

Savon à la Maréchale.

Lard, with musk	10 lbs.
„ amberette	10 „
Pomade (aux fleurs) cassia, jasmine, and rose, of each	10 „
Olive-oil	1 lb.
White wax	2 lbs.
Gum tragacanth	2 „
Caustic ley, 36° B.	28 „

Saponify carefully and colour with a little caramel (burnt sugar).

Lettuce Soap.

Lard, with lettuce	20 lbs.
Cassia pomade	10 „
Spermaceti	5 „
Castor-oil	5 „
Palm-oil (bleached)	10 „
Caustic ley, 36° B.	26 „
Gum tragacanth	3 ozs.

Perfume with

Oil of bergamot	6 ozs.
„ thyme	2 „
„ valerian	1 oz.
„ cloves	1 „

Colour light green.

The lard with lettuce is made by melting the lard with its own weight of lettuce-leaves, keeping it at the melting-point—about 90° F.—for some hours, or until the leaves have parted with their colour and their juice. Then steam off for use.

Ambergris Soap.

Grease, perfumed with ambergris and musk	25 lbs.
Jasmine pomade	10 „
Rose	10 „
Gum tragacanth	3 ozs.
Caustic soda ley, 33° B.	25 lbs.

Colour light brown with caramel.

This soap is made of select materials by the cold process, and after being made is allowed a few days to dry before melting. The musk and ambergris have to be added to the grease some weeks before, frequently melting and stirring.

Elder-flower Soap.

Half-palm soap	100 lbs
Dextrine	3 „

Perfume with

Oil of bergamot	8 ozs.
„ lavender	2 „
„ thyme	2 „
„ cloves	1 oz.
„ cassia	½ „
„ almonds	½ „

Colour light green.

Lemon Soap.

White soap	50 lbs.
Starch	2 „

Perfume with

Oil of lemon	4 ozs.
„ bergamot	2 „
„ lemon-grass	2 „
„ cloves	1 oz.

Colour light yellow with cadmium yellow.

Orange Soap.

White soap	50 lbs.
Starch	2 „

Perfume with

Oil of orange-peel	8 ozs.
„ cinnamon	½ oz.
„ thyme	2 ozs.

Colour dark yellow with naphthaline yellow.

Glycerine Soap.

Tallow (mutton)	44 lbs.
Cocoa-nut oil	44 „
Castor-oil	22 „
Glycerine (pure)	22 „
Caustic ley, 40° B.	27 „
Alcohol, 96°	48·4 „
Water	9·9 „

Melt the grease at 104° F., and add the alkali by slow degrees, keeping the heat low to prevent evaporation, and stir constantly. When the ley has become absorbed, after three or four hours' stirring add the alcohol, which should be warmed; stir till it becomes clear, then add the glycerine, and when mixed, the water and perfume: turn into

the frame, pouring slowly. This soap, if carefully made, is a very superior one.—*Cristiâni.*

The same author gives the following formulæ for preparing white Castile soap, with or without olive-oil :—

1. Olive-oil	40	part
Ground suet	30	,,
Tallow	30	,,
2. Olive-oil	30	,,
Lard	30	,,
Palm-nut oil	40	,,
3. Olive-oil	30	,,
Cotton-seed oil	30	,,
Tallow-oil	40	,,
4. Palm-oil (bleached)	50	,,
Sesame-oil	20	,,
Tallow	30	,,

Savonnettes, or Washballs.—These may be made from any of the milder toilet soaps, or from the subjoined formulæ. The spherical form is given by pressing the soap in moulds, or by first forming them into balls with the hand, and when quite dry and hard turning them in a lathe. According to Mr. Beasley, "they are formed into spherical balls by taking a mass of the prepared soap in the left hand, and a conical drinking-glass with rather thin edges* in the right. By turning the glass and ball of soap in every direction the rounded form is soon given; when dry, the surface is scraped, to render it more smooth and even."

Washballs are sometimes made with the addition of powdered starch or farina, and sometimes sand. Having but a comparatively limited sale, they are usually prepared in small quantities.

Violet Washballs.

Palm-oil soap	4 lbs
Farina (starch)	2 ,,
Fine powdered orris	1 lb.

Cut the soap into fine shavings and melt over a hot water-bath, adding a small quantity of water. Then add the farina and incorporate it well by stirring. Lastly, add the orris powder, and mix well.

* A brass tool is commonly used for this purpose.

Honey Savonnettes.

Finest yellow soap	7 lbs.
Palm-oil soap	¼ lb.

Melt and then add

Oil of verbena, rose, geranium, or ginger-grass ...	1 oz.
Oil of rosemary	½ „

Savonnettes of Sweet Herbs.—Melt 12 lbs. of white curd soap, and then add the following mixture of essential oils:—

Oils of lemon and bergamot, of each	4 ozs.
„ thyme, lavender, wild thyme, myrtle, and marjoram, of each	1 oz.
„ mint, sage, and wormwood, of each	½ „
„ fennel	2 ozs.

Savonnettes of Camphor.

White curd soap	3 lbs.

Melt, with the addition of a little water, and then add

Spermaceti	4 ozs.
Camphor (cut small)	2 „

These are first to be melted together, and then added to the liquid soap.

Savonnettes of Neroli.

Melted curd soap	12 lbs.
Orris powder	1 lb.
Orange powder	3 ozs.
Oil of neroli	12 drms.
Essences of musk and ambergris, of each	4 ozs.

Savonnettes à la Vanille.

White curd soap	12 lbs.

Melt, with a little water, and then add the following mixture:—

Tincture of vanilla	4 ozs.
Balsam of Tolu	4 „
„ Peru	2 „
Tincture of cinnamon	1oz.
Oil of cloves	2 drms.
Tinctures of musk and amber, of each	1 oz.

Marbled Savonnettes.—These may be formed as follows:—For *red*, cut white curd soap into small squares, and roll these in powdered *bole* or rouge, then press them strongly with the hands into balls, taking care to mix the colour as little as possible. For *blue*, roll the pieces of soap in powder blue, and then treat them as above. For *green*, roll the cakes of soap in a mixture of yellow ochre and powder blue. By varying the colour of the powder savonnettes of any shade or colour may be produced.

A very pleasing and real marbled appearance may be given to soaps in this way: Melt in one vessel any required quantity of white curd soap, adding a little water. When thoroughly melted put a small quantity of the soap in a separate vessel, previously warmed, and add to it a sufficient quantity of ultramarine, vermilion, or any other colour (previously mixed with a little water), to stain the soap. Now add the coloured to the white soap, and stir round and round in one direction only until the coloured soap has formed a series of circular veins in the mass. Care must be taken to do this slowly, so that the coloured soap may merely *streak* the white soap. Allow the soap to cool, when it may be scooped out in small lumps with a half-round and bright trowel, and these marbled lumps may then be fashioned into balls or tablets according to requirement. If preferred, the marbled soap may be carefully put into a frame while hot, but this must be done cautiously, so as not to *mix* the colour with the white ground. The required perfumes should be added to the white soap before the coloured soap is introduced.

Savonnettes au Miel (Honey Savonnettes).

White curd soap (melted)	1 lb.
Honey	1 ,,
Essential oil of any kind required	2 ozs
Rose-water	2 ,,

Add the honey to the melted soap, then add the rose-water, and lastly the perfume.

Floating Savonnettes may be made by adding a little water to any of the perfumed soaps in a melted state, and

briskly stirring the mass, so as to mix or beat air into the soap. This agitation should be kept up until the mass is at least doubled in volume.

Sand-Balls are made by incorporating with melted and perfumed soap certain proportions of fine river sand. About one-third sand to two-thirds soap is a fair proportion. The sand, however, should be passed through a fine sieve before using. Sometimes finely-powdered pumice is substituted for the sand.

CHAPTER XX.

SOFT TOILET SOAPS.

Naples Soap, or Almond Cream.—French Method.—White Soft Toilet Soap.—Powdered Soaps.—Shaving Paste.—Essence of Soap.—Essence de Savon Vienne.—Essence de Savon Corinthe.—Transparent Soap.

THE alkaline base of these soaps is potash, and the fatty matter generally used is good hog's lard, though sometimes cocoa-nut oil is introduced to promote the lathering properties of the soap. This latter oil, however, should be used sparingly, since it invariably leaves a disagreeable odour on the skin after washing—a serious objection in toilet soaps.

Naples Soap, or Almond Cream.—This elegant preparation, which has been much used as a shaving soap, is prepared as follows:—A potash ley, marking 36° B., is first prepared. Now take 20 lbs. of clarified hog's lard, and place this in a small copper jacket-pan or other convenient vessel, and apply *gentle* heat, stirring continually with a wooden stirrer. When the lard is about half melted, but free from lumps, add 5 lbs., by weight, of the potash ley, and continue the agitation and also the same degree of temperature, when, after an hour or so, soap granules will have deposited at the bottom of the pan, while a layer of unsaponified fat will float on the surface. Another 5 lbs. of the same ley must now be added and the mixture stirred, when the granules and oil will disappear, and the mass assume the form of a paste. The heat and occasional stirring must be kept up for about four hours, by which time the mass will become a stiff paste, when it requires to be beaten lightly. The heat should then be withdrawn,

and the pan closely covered over, so that the cooling may be *very* gradual and slow.

When quite cold, the soap is to be put into a marble mortar and well pounded with a wooden pestle, by which process the separated particles become united, and a perfectly homogeneous paste formed, which has a beautiful pearly lustre; hence it is sometimes called *pearl* soap. This preparation is usually perfumed with oil of bitter almonds; hence it is also called *almond cream.*

French Method.—Fifty pounds of hog's lard and 10 lbs. of cocoa-nut oil are placed in a steam-jacket pan, and melted; 50 lbs. of potash ley marking 20° or 21° B. are then added gradually, with constant stirring, and the heat of the mass is to be kept at from 140° to 158°. After a while the mass thickens, by the evaporation of the water from the ley; if a tendency to separation of the fatty matter is exhibited, the heat must be lowered, and if necessary, a little stronger ley added until saponification is complete, which generally occupies about four hours. To finish the operation, 30 lbs. of potash ley at 36° B. must now be added, with continual stirring, and care must be taken to keep the heat below the boiling-point of water. When the paste has become quite stiff, the steam is to be turned off, and the paste allowed to cool down, after which it is put into stone jars for future use. To convert this into *pearl soap* it is pounded in a marble mortar, a few pounds at a time; from 1½ to 2 drachms of oil of bitter almonds being added for each pound of soap. When the soap is required to be of a delicate rose colour, from 15 to 30 grains of vermilion to each pound of soap must be added, and well incorporated by the pestle and mortar.

Although the oil of bitter almonds is principally used as a perfume for these *soap creams,* as they are called, other fragrant substances are occasionally employed. For example, *Crême Ambroisie* is perfumed with liquid storax and benzoin, and *Crême de Cacao Mousseuse* with oil of cacao.

White Soft Toilet Soap.—Cristiani gives the following

directions for making a white soft toilet soap:—Melt in a sheet-iron kettle, of a capacity of about 50 gallons, 50 lbs. of white fat and 13 lbs. of cocoa-oil. When the fatty matters are entirely melted, add 50 lbs. of potash ley at 20° or 21° B. Stir all the time, so as to aid the saponification, the temperature being kept at from 140° to 150° F. Under the influence of heat and stirring the aqueous part of the ley evaporates and the mixture acquires a thicker consistency. Sometimes it happens that a part of the fatty matter separates. This is produced especially where the temperature of the mixture is raised near the boiling-point, because at that temperature concentrated leys have little affinity for fatty substances. This effect may also be produced by the insufficiency of alkali in the mixture. In the first case the homogeneity is re-established by moderating the action of the heat, and in the other by pouring into the kettle a portion of strong ley necessary to complete the saponification. The first stage of the operation lasts about four hours. To obtain a perfect soap, add 10 lbs. of potash ley at 16° B., and be careful to keep the mixture very uniform by continual stirring. Keep the temperature below the boiling-point, and as much as possible between 140° and 150° F.

The saponification is finished when the paste has acquired a very thick consistency. At this point turn off the steam.

Many perfumers prepare this soap in iron kettles with a double bottom, heated by steam; some use silver kettles, which are preferable, because in them the soap will retain its whiteness. The engraving Fig. 26 represents a jacket or kettle with a double bottom, heated by steam. This kettle is of tinned copper, and may be also used to purify tallow and greases. The operation lasts in all from seven to eight hours. When the soap is entirely cooled down, pour it into large stone jars, in which it is kept for use. Soft soap, as obtained by the saponification of fatty matters by potash, has not that bright nacreous (pearly) appearance required for the toilet. To obtain it in this state it is ground in a marble mortar and aromatised with oil of bitter almonds.

Powdered Soaps.—All hard soaps may be reduced to a fine powder, when perfectly dry, by trituration with a pestle and mortar, but the operation is generally confined to cosmetic soaps for shaving or other toilet purposes. The soap, being previously perfumed in the usual way, is cut into thin shavings, and these are laid upon sheets of paper and placed in the drying-room, or dried in any convenient way. As soon as the shavings become brittle they are in a condition for powdering. Small quantities at a time should be carefully reduced to a powder in a mortar, and the powder afterwards passed through a fine sieve, the fine powder being placed in a jar and kept well covered. All coarser particles retained by the sieve should then be pulverised and sifted as before, until the entire quantity is reduced to a powder fine enough to pass through the sieve.

Although it is better to colour the soap in the ordinary way before powdering it, the colouring matter may, if preferred, be introduced into the mortar when the soap is about half reduced to powder, and then worked up with the soap until thoroughly incorporated. For rose-colour, about one drachm of vermilion to each pound of soap should be used. For yellow, from one to two drachms of finely-powdered gamboge. Other shades of colour, however, may be given if desired.

Powdered soaps, named after their respective perfumes, are much esteemed as shaving soaps by the fastidious; and perhaps the so-called rose soap, perfumed with oil of rose and tinted by vermilion, may be considered one of the most delicate preparations, provided that it has been made from a good white tallow soap free from cocoa-nut oil.

Shaving Paste.—This popular cosmetic may be prepared in various ways, but the following formulæ may be taken as representing the mode of manufacture: 1. Take Naples soap, 1 lb.; Castile or Marseilles soap, ½ lb.; honey, ½ lb.; essence of ambergris, oils of cassia and nutmeg, of each 20 to 30 drops. Mix these ingredients well together in a mortar, adding a little rose-water, until a perfectly homogeneous paste is formed. 2. Take of white or virgin

wax, spermaceti, and almond oil, of each 2 ozs.; melt over a water-bath, and then add 3 ozs. of Windsor soap previously worked up into a paste with a little rose-water. Mix all well together and place in a jar, which should be kept well covered. 3. White soft soap, 12 ounces; spermaceti and olive-oil, of each 1½ oz. Melt these ingredients all together, and stir until the mass is nearly cold; perfume with any essential oil, or a mixture of perfumes, according to taste.

Essence of Soap.—Under this title various preparations are made; but they are all solutions of soap in warm alcohol, with, generally, the addition of a small quantity of potash. Soaps made from vegetable oils are preferred, because they remain clear and liquid when cold, whereas those prepared from animal fats become solid in cooling. Dussauce gives the following formula for preparing this soap:—

White Marseilles soap	6½ ozs.
Alcohol at 85°	1 quart.
Potash	6 drms.

Cut the soap into fine shavings, and put them into a bottle holding about half-a-gallon (a "Winchester" bottle would suit admirably); add the alcohol and potash, and heat gently, without boiling, over a water-bath; stir with a glass rod. When the solution is complete, take it out of the water-bath, and add the essences. A very sweet perfume may be given to this preparation by adding to it—

Oil of geranium	1½ drm.
„ verbena	2½ drms.

To colour yellow, add 2½ drachms of saffron.

This essence continues limpid at the ordinary temperature. To use it, pour a little into half a tumbler of water and stir quickly.

Essence de Savon Vienne.

White Soap	3 ozs.
Carbonate of potash	1 drm.
Alcohol at 95°	18 ozs
Lavender-water	6 „

Digest and filter.

Essence de Savon Corinthe.

Dry white soap	10 ozs.
Alcohol at 80°	1 quart.
Potash	2 ozs.
Essential oil	a few drops.

Digest as before.

Any perfumed toilet soap may be converted into an "essence," but doubtless the white Castile soap would form the most elegant preparation, besides being the most emollient.

Transparent Soap.—Soap, when perfectly dry, is readily soluble in warm alcohol, and advantage is taken of this chemical fact in the manufacture of *Transparent Soap*—perhaps the most elegant form which this substance is capable of assuming.

To prepare transparent soap, either tallow, almond, or soft soaps may be used, but in either case the soap must be rendered perfectly free from water. The soap is first cut into thin slices or shavings, and these are then dried over a water-bath, or by hot air. Equal parts by weight of the dried soap and rectified spirit are put into a still, heated by a water-bath. Only moderate heat is applied, otherwise the spirit would pass over without dissolving the soap. It is sometimes the practice to powder the soap in a mortar after drying before treating it with the spirit, by which it becomes more readily dissolved. If it is desired to colour the soap, any colouring matter soluble in alcohol may be employed, and it is best to colour the spirit before adding it to the soap.

When the soap is completely dissolved, it is allowed to rest for an hour or more, according to the quantity, after which the clear and transparent liquid is put into the frames, in which it will solidify on cooling. When cold the soap is cut into pieces of any required size, and these are moulded in the same way as other toilet soaps. The soap does not, however, acquire its characteristic transparency until after it has been exposed to dry air for a considerable time. To colour the soap red, a strong tincture of archil may be used, and for yellow turmeric may be

employed. Any of the aniline colours, however, may be used for tinting the transparent soap, and are, indeed, well suited to this purpose.

Resin soaps are considered very suitable for making these soaps, and the presence of a fair proportion of resin undoubtedly favours the transparency and beauty of the substance.

Although transparent soaps are exceedingly pleasing to the eye, they do not possess the active detergent powers of ordinary soaps.

CHAPTER XXI.

MEDICATED SOAPS.

Sir H. Marsh's Sulphur Soap.—Mercurial Soap.—Medicinal Soft Soap.—Antimonial Soap.—Carbolic Acid Soap.—Medicated Tar Soap.—Tooth Soap.—Liquid Glycerine Soap.—Bordhardt's Herb Soap.—Arsenical Soap.—Soap for Washing Dogs.—Turpentine Soap.—Tar Soap.—Black Soap.—Various Substances introduced into Manufactured Soaps.

MANY different substances have been introduced into soap for the relief or cure of cutaneous affections and for other purposes, amongst which may be mentioned the following:—

Sir H. Marsh's Sulphur Soap.—White soap 2 ozs. and sublimed sulphur ¼ oz. are triturated in a mortar, with 1 or 2 fluid drachms of rectified spirit, until a smooth paste is formed. The spirit should be first coloured strongly with alkanet root. A few drops of otto of roses are added to give the soap an agreeable fragrance.

Mercurial Soap is made from powdered Castile soap 4 ozs., corrosive sublimate 1 drachm, dissolved in rectified spirit 1 fluid oz. These ingredients are to be *thoroughly* mixed in a Wedgwood mortar.

Medicinal Soft Soap is made from pure olive-oil saponified with a caustic ley made from pure potash. The ley is added gradually and cautiously to the oil during the boiling, and the greatest care taken to avoid an excess of alkali. When the mass assumes a transparent and gelatinous appearance, the addition of ley is stopped. The boiling is continued until the soap has acquired the proper consistence.

Antimonial Soap.—Pure Castile soap (white) in powder 1½ oz., golden sulphuret of antimony 2 drachms, solution of caustic potassa 6 drachms. Dissolve the sulphuret in the potash and add to the soap; then triturate in a mortar until a stiff paste is formed. It should have a greyish-white colour.

Carbolic Acid Soap.—As a powerful antiseptic, carbolic acid had long been known, but it was not until the late Dr. Crace-Calvert had developed its manufacture upon an extensive scale that its usefulness could be fully taken advantage of. Since then, however, its employment as a disinfectant and deodoriser has become universal, and its incorporation with soap, which has taken the name of *Carbolic Soap*, has been very extensive. Indeed, this article has now become a necessary and useful article of commerce. About 2 per cent. of carbolic acid is added to soap in a melted state, and thoroughly incorporated by crutching. It is then put into a frame, and when cold is cut into squares and moulded in the same way as ordinary fancy soaps, or, for more extensive use, it may be formed into bars of the ordinary size. Carbolic soap may be prepared from the following:—

Half-palm soap	20 lbs.
Starch	1 lb.
Carbolic acid, in crystals	1 oz.
Oil of lavender	2 ozs.
,, cloves	1 oz.

Medicated Tar Soap.

Cocoa-nut oil	20 lbs.
Tallow	10 ,,
Juniper tar	5 ,,
Soda ley, 40° B	15 ,,

Tooth Soap.

Tallow soap	20 lbs.
Pumice powder (finely sifted)	½ lb.
Prepared chalk	2 lbs.
Starch	½ lb.

Liquid Glycerine Soap is thus made:—

Oleic acid	187 lbs
Cocoa-nut oil (best)	33 ,,
Potash ley 30° B.	114 ,,
Glycerine	10 ,,

The ingredients are saponified at a gentle heat, and sufficient alcohol at 95° added to make the soap clear.

Bordhardt's Herb Soap.

Olive-oil soap	30 lbs.
Palm-oil soap	20 „
Dextrine	2 „

Perfume with

Oil of rosemary	2 ozs.
„ lavender	1½ oz.
„ thyme	1½ „
„ sage	1 „
„ magnolia	1 „
„ peppermint	1 „

Colour blue.

Arsenical Soap is used by bird and animal stuffers to preserve the skins from the attacks of insects. It is prepared by the following formula:—White soap, arsenious acid, and lime slacked by air, of each 4 ozs.; carbonate of soda, 12 ozs.; powdered camphor, ¾ oz. The whole of these ingredients are worked up into a paste, with pestle and mortar, a small quantity of water being added during the mixing.

A Soap for Washing Dogs and other animals is sometimes made by mixing Stockholm tar (wood tar) with melted soap. The tar should first be dissolved in pyroxylic spirit (wood naphtha).

Turpentine Soap, or Starkey's Soap, is prepared as follows:—Take of Venice turpentine, oil of turpentine, and carbonate of potash, of each equal parts; place these in a mortar (previously warmed), and triturate them together, adding a little water, until a homogeneous mass is formed; put it into a paper mould, and after a few days cut the soap into slices, and keep them in a well-stoppered bottle.

Tar Soap is made from soap cut into shavings, 2 parts; tar, 1 part; and liquor of potassa, 2 parts; the whole being intimately mixed in a mortar.

Black Soap, or Farrier's Soap, is a coarse kind of soft soap, made from fish oils and caustic potash; sometimes tar is added. Besides the substances above named, iodine,

bromine, creosote, and many other chemical substances have been employed for making what are sometimes termed *skin soaps*, but they are all prepared much in the same way as above indicated.

Various Substances introduced into Manufactured Soaps.—The following percentages of foreign substances which are added to manufactured soaps are thus given by Cristiani * :—

Tannin soap, 3 per cent. of tannic acid.

Salicylic soap, 2 per cent. of salicylic acid.

Disinfectant soap, carbolic acid, about 2 per cent.

Thymol soap, 3 to 5 per cent. of thymol.

Croton-oil soap, 2 per cent. of croton-oil.

Benzoic soap, 2 per cent. of benzoic acid.

Castor-oil soap, 20 per cent. of castor-oil with other fats.

Petroleum soap, 20 per cent. of petroleum-oil added to the other fats before saponification.

Paraffin soap. The wax is added to the amount of 10 per cent to the fats before saponification.

Creosote soap, 2 per cent. of creosote.

Iodine soap, 2 per cent. of iodine.

Turpentine soap, 5 per cent. of oil of turpentine.

Borax toilet soap, 10 per cent. finely powdered borax.

Mercurial soap, 6 per cent. of mercurial ointment.

Irish moss soap, 5 per cent. of Irish moss dissolved in a suitable quantity of water and strained.

Bran soap, 10 per cent. of bran.

Cornmeal soap, 10 to 20 per cent. of maize-flour.

Oatmeal soap, 10 to 20 per cent. of oatmeal.

Camphor ice soap, 5 per cent. of camphor added to cold cream soap would be very suitable.

Wax soap, 10 per cent. of wax added to soap. It has some good and useful properties.

* "Technical Treatise on Soap and Candles."

CHAPTER XXII.

MISCELLANEOUS SOAPS.

Soap to be used in Cloth Manufactories.—White Cocoa-nut Oil Soap.—Dresden Palm Soap.—Altenburge's Resin Soap.—Ox-gall Soap.—Scouring Balls.—Borax Soft Soap.—Borax Soap-Powder.—London Soap-Powder.

Soap to be used in Cloth Manufactories, &c.—Kürten makes the following interesting observations on the preparation of soaps to be used for milling and other similar purposes,* which will assist in guiding the soap-maker who may not be fully acquainted with the requirements of the cloth-scourers. "In preparing all soaps intended for the use of the above-mentioned establishments, great care is indispensably necessary in giving the ley its proper proportion of strength, for if the ley be too weak the stuffs cannot be properly cleansed, and also a greasy matter is communicated to them which in every case is very injurious; on the other hand, if the ley is too strong in the soap, the stuffs are scoured too much, and retain always a dry stiffness which should be specially avoided. When the cloth is scoured or milled it is a rule to use soap of a quality corresponding with that of the stuffs, for it is proved by experience that a cloth which is really good, and which is called stout cloth, must be milled a longer time than a zephyr or light stuff for pantaloons, which only require to be washed, else they would loose the elasticity which is indispensable to them.

"In executing an order for soap for milling, the maker should direct his attention to ascertain whether the process of milling was according to the ancient manner by stocks or the new method by cylinders. By the first

* "Art of Manufacturing Soap." By Philip Kürten.

method the milling requires longer time and the employment of a soap which does not dissolve too quickly, whilst by the latter method a soap is wanted which does not congeal too quickly. Among the soaps which do not dissolve quickly we reckon those which are prepared from tallow or palm-oil with soda ley, from which it is afterwards separated. A soap which dissolves the quickest is that which has been boiled from olive-oil, with an addition of tallow, then some olein soap; in a word, the genuine soap. It is, however, true that green or brown soap always dissolves quickest; nevertheless it is not fit for milling heavy cloth with the stocks, because on that account they do not thicken sufficiently. Although the manufacturers of cloth will not easily decide on using any other sort of soap, yet the soap-boiler should not be led away by the opinion that every maker of the same article can make use of the same sort of soap, because, as we have already observed, not only the different qualities of cloth and the method employed in their manufacture should be taken into consideration, but also the different properties of the water used. It is, therefore, the duty of every soap-boiler to supply each manufacturer with the kind of soap which, in that manufacturer's own opinion, is the best adapted for his purpose and for the quality of his material. We will for that reason more fully describe the preparation of the different sorts of soap.

"*Hard and Unsalted Soap for Milling Cloths of Superior quality.*—This kind of soap is made either of tallow or cocoa-nut oil, or whitened palm-oil with an addition of cocoa-nut oil, and in the following manner:—The palm-oil or the tallow should be boiled into a firm-grained soap with a caustic soda ley,* which is added till the soap shows a strong grain and bears a good pressure of the hand, and the sample shows a sufficient firmness when cool, and when the ley, which still remains unsalted in the soap, leaves a sharpish taste on the tongue. We have then a soap, it is true, but it is not fit for milling, because it does not yet possess a sufficient scouring

* Mr. Kürten is in error in recommending soda soaps for these purposes.

quality, therefore will not cleanse the cloth from its dirt, glue, and grease. To give the soap the necessary power to effect that purpose an addition of cocoa-nut oil is requisite, and for that reason the unsalted ley which remains in the soap must be got rid of, and the soap poured again into the boiler, but without any ley. For every 100 lbs. of palm-oil or tallow used for this soap 25 lbs. of cocoa-nut oil must be added, which is mixed with the soap when cold in small quantities, or, which is more advisable, when in a state of solution, and then made to boil afresh. When it is intended to make a soap of a superior quality and to diminish the ley, in order to saponify cocoa-nut oil a caustic ley of soda of 28° or 30° is required. The ley is added till the soap has acquired a good firmness, and, when tried, a taste rather strong of ley remains on the tongue. As soon as this is found, then the soap must be allowed to boil for half an hour to ascertain whether the same taste yet remains; if not, a little more ley must be added till the taste returns. When the soap is not yet separated from the ley, to effect that purpose some salt must be used, and continued till the soap on the spatula separates from the ley. The soap will remain some hours in the boiler to cool, and be afterwards poured into the frame. When it is desired to obtain a larger produce, although with the conviction that the quality will not be so good, instead of a ley at 28° or 30° for the saturation of the cocoa-nut oil, one 22° to 24° must be used, and the soap poured into the frame in the state of paste, and not unsalted; but in this case care must be taken that the soap is not brought to a higher degree of heat than 25° Réaumur (152°), otherwise the soap from the cocoa-nut oil would stick to the bottom of the boiler."

White Cocoa-nut Oil Soap.—Cristiani gives the following directions for making this soap in a simple and quick way:—To prepare 100 lbs. of this soap, introduce into a kettle* holding from 200 to 250 gallons, 200 lbs.

* The term "kettle" is generally used in America in preference to soap-pan or copper.

of pure white cocoa-nut oil; afterwards add 200 lbs. of colourless and perfectly limpid ley at 30°. All being ready, heat the kettle, and to accelerate the combination of the substances stir well from time to time. Under the influence of the heat the material, which was at first in the form of grains, softens and becomes liquid. Continue the heat gently and gradually until the combination of the oil and alkali is effected, which generally takes place when the ebullition begins. When properly made, the soap has the appearance of a fluid, homogeneous, and syrupy paste of an amber-white colour. It is useless to boil it; stop off the heat, and run the soap into the frames. If, when the mixture begins to boil, a certain quantity of oil swims on the surface of the paste, it may be combined with the saponified mass by adding 10 lbs. to 12 lbs. of cocoa-nut oil soap; or, the same result may be obtained by adding from 2 to 2½ gallons of pure water. After stirring a few minutes the homogeneity of the soap is re-established and the combination perfected. The heat is then withdrawn, and the soap transferred to the frames as usual. After five or six days the soap is firm enough to cut. By the above process the soap is very white, does not contain any excess of alkali or oil, and may be employed for toilet uses. From the quantities given from 396 to 400 lbs. of soap are obtained, according to the quantity of water added. The operation lasts about one hour.

Dresden Palm Soap.

Cocoa-nut oil	3,520 lbs.
Palm-oil (crude)	1,100 ,,
Resin	880 ,,
Soda ley, 28°	353 ,,

Melt together the fats and saponify the resin separately, taking care to add the resin soap before it becomes too thick to stir.

Altenburge's Resin Soap.

Cocoa-nut oil	220 lbs.
Resin	220 ,,
Soda ley, 28° B.	297 ,,

Make by the cold process, and cut with a salt ley of 24° B. before framing.

Ox-gall Soap.

Purified ox-gall	1 part.
White curd soap	2 parts.

The soap is cut into shavings and melted in the ox-gall at a moderate heat, evaporating until of proper consistency. The ox-gall is prepared by boiling it with 10 to 12 parts of wood spirit and straining.

Scouring-Balls.

White curd soap	35 lbs.	2 ozs.
Pearlash	6 ,,	6 ,,
Oil of juniper	3 ,,	3 ,,

Mix together, having previously added a little water to the soap and pearlash to dissolve them by a moderate heat; add the oil of juniper and mould into balls.

Borax Soft Soap.

White fats	100 lbs.
Soda ley, 15° B.	100 ,,
Potash ley, 10° B.	60 ,,
Solution of borax, 10° B.	15 ,,

The soda ley is added to the melted grease and heated till it forms a clear liquid or is combined, when the potash ley and borax solution are added. It should be a semi-solid translucent paste, and is usually sold in quart cans.

Borax Soap-powder.

Curd soap in powder	5 parts.
Soda ash	3 ,,
Silicate of soda	2 ,,
Borax, crude	1 part.

Each ingredient is thoroughly dried and all mixed together by sifting.

London Soap-powder.

Yellow soap	6 parts.
Soda crystals	3 ,,
Pearlash	1½ part.
Sulphate of soda	1½ ,,
Palm-oil	1 ,,

These ingredients are combined as well as possible without any water, and they are spread out to dry and then ground into a coarse powder. Thus in an infinite degree can the variety of soap-powders be multiplied. They are adapted for hard waters, as their excess of alkali neutralises the lime.—*Cristiani.*

CHAPTER XXIII.

MISCELLANEOUS PROCESSES.

Jennings's Processes. — Levat's Process.—Violet's Palm-oil Soap.—Hampel's Shaving Soap.—Marriott's Process.—Sawdust in Soap.—Lewis's Process.—Borax Soap.—Camphor and Ammonia Soaps.—Mackay and Seller's Process.——Petroleum Soap: Bastet's Process.—Besson and Remy's Process.—Tardani s Process.—Half-resin Soap.—Payne's Process.—Bankmann's Process.—Jeyes's Process.—Varicas's Process. -Lorbury's Process.—Cleaver's Terebene Soap.—Scharr's Liquid Soap.—Bichford's Process.—Marking Soaps.

APART from the ordinary, or, if we may say so, recognised soaps, innumerable patents have been taken out from time to time for various "improvements," modifications, or additions, the merits of which may easily be determined by a small trial when the new process does not, which is too frequently the case, bear the brand of absurdity "on the very face of it." The following abstracts from a few of the patent specifications will enable the reader to form his own judgment as to whether any of the processes described in brief will be worth a further acquaintance, in which case he will naturally obtain a copy of the specification, and if necessary, put himself in communication with the patentee, provided, of course, that such patent is in full force.

Jennings's Processes.—1. Combine 1,000 lbs. of stearic or margaric acids, as free from olein as possible, or palmitin or any vegetable or animal stearin or margarin, at the temperature of 212° F., with a solution of bi-carbonate of potassa or soda of a specific gravity of about 1,500°; stir constantly until an intimate combination is obtained, and no separation visible when tried with the shovel or trowel. When the mass has cooled down to

about 60° F., add 1 lb. per cent. of liquid ammonia of about ·880°, and 1 lb. per cent. of the strongest solution of caustic potassa; these are to be added gradually, and well mixed by stirring until perfectly combined. Dissolve 15 to 18 per cent. of resin by boiling it with a solution of carbonate of potassa and soda in equal parts, or as much as will give the solution a specific gravity of or about 1,800° when boiling hot. Mix these perfectly with the stearic or margaric acids and carbonated alkali; then add a strong solution of caustic potassa or soda, until perfect saponification is produced. The dose of caustic alkali will much depend upon the purity of the stearine or margarine employed. The separation is now effected by using common salt or sulphate of soda as usual. If the soap is to be colourless, no resin must be employed, and a larger dose of liquid ammonia and caustic alkali must be used according to the dryness of the stearine to be operated upon.

2. White curd soap is dissolved in about one-third of its weight of water, to which is added *colophony* (black resin), carbonate of soda, and alum. For this purpose the resin (at the rate of 25 per cent. of the quantity of soap) is dissolved with about 6 per cent. of carbonate of soda of commerce to the resin employed, using about a like weight of water as there is of the resin. These matters being boiled together till the resin and alkali are dissolved, the compound is to be added to the dissolved soap, and the whole of the matters are to be boiled till the workman on taking a sample finds that the soap is hard and smooth, as is well understood by soap-boilers. To this compound is to be added a quantity of sulphate of alumina (common alum) with a view to improve the colour, say from about 2 to 4 per cent. of the tallow or oil and resin in the mixture, using more or less of the alum according as the resin is less or more pure. The whole compound is to be boiled up, and then allowed to stand from two to four hours. In order to prevent the resin precipitating, a quantity of dilute sulphuric acid is introduced and stirred into the above mixture. The strength of each solution of acid

which is used is 1 part by weight of sulphuric acid to 9 parts by weight of water, of which about 2 per cent. in respect to the weight of tallow or oil and resin in the mixture is to be employed. The compound is, then to be fitted, cleansed, and framed as usual.

Levat's Process.—The object of this process is to utilise the waste or residual, oily products resulting from the distillation of essential oils, and to add to the emolliency of the soap by the employment of lichen. The fatty matters are first heated to expel the alcohol left in them after the process of distillation, and they are then heated with a weak soda ley, after which stronger leys are used to complete the saponification. When the soap separates and the grain has the proper consistence, an infusion of lichen is added, when a perfectly smooth paste is formed. The soap consists of.—

Fatty matters	58 parts.
Soda	6 ,,
Water	34 ,,
Lichen	2 ,,

Violet's Palm-oil Soap.—100 lbs. of palm-oil are melted, and at the temperature of 203°, 12½ ozs. of nitric acid are added, with vigorous stirring for about a quarter of an hour; 12 gallons of hot water are then added, and the stirring continued, after which the oil is allowed to rest. The oil is then well washed several times to free it from the acid, and after being separated from the water is saponified with a weak ley at 8° B., followed by stronger leys of 10° and 15°. The boiling is kept up until the soap is of the proper granular consistence, and the grained soap, after being separated from the ley, is dissolved with lemon juice. This soap is called "Orangine."

Hampel's Shaving Soap is made by his patented process as follows:—Cleaned olein 6·6 per cent. is first mixed thoroughly with 13 per cent. of hot water; then 5·4 per cent. of soda ley at 25° is added, and the mass, which assumes the appearance of soft butter, is agitated until it becomes cold and is easily liquefied, when 12·5 per cent. of best white soap and 50 per cent. of boiling

water are added. All these ingredients are to be well mixed together, and finally 12·5 per cent. of spirit at 90° is to be added and well incorporated with the mass. The compound is then to be covered, and allowed to rest for a while, after which it is to be filtered, and is then ready for use.

Mrs. Marriott's Process.—For making "a washing or cleansing compound," the inventor mixes with common yellow or any fancy or toilet soap about an equal proportion of very finely-powdered pumice, which is added to the soap in its melted state. The powdered pumice is to be thoroughly incorporated with the soap, so as to be equally distributed throughout. This compound combines the detergent qualities of the soap with the frictional action of the pumice; at the same time, when used for washing or cleansing purposes, the soap lubricates the particles of the powdered pumice and modifies its abrasive action, thus preventing injury to the finest fabrics.

Sawdust in Soap.—Mr. Waller forms a washing or cleansing compound by adding to melted soap certain quantities of sawdust, and well mixing the whole together by stirring or crutching. The sawdust may, if preferred, be introduced during the process of manufacture in the same way that other ingredients are added to soap.

Lewis's Process.—Mr. Lewis mixes potato flour, dextrine, or other suitable farinaceous substances with a viscous solution of soluble glass or solution of silicate of soda or silicate of potash, in the proportion of about one part flour to ten or twelve parts of the silicate. The soap is manufactured from oleic acid in the usual way, with the addition of a small quantity of resin, say about one part of resin to about ten parts of soap. When the process is finished, and while the soap remains hot and in a fit condition for running into the cooling frames, the above compound of the silicate and farinaceous substance is added in the proportion of about one part by weight to three parts of the soap, more or less. These materials are thoroughly incorporated or mixed by crutching and stirring, and then the whole is transferred to the frames as usual.

For household or laundry purposes he uses by preference a soap made of oleic acid mixed with common tallow or animal grease and resin; if necessary, he adds a certain proportion of French chalk to give firmness to the soap. The solution of silicate of soda should have a specific gravity of about 170° by Twaddell's hydrometer.

Borax Soap.—Mr. Rowbottom produces "borax dry soap, or soap powder" by adding borax to the usual carbonated or silicated ash or alkali, or other substance used in the manufacture of dry or powder soaps. For *borax soft soaps* he adds a solution of borax to the ingredients usually employed for making ordinary soft soaps before or during the manufacture, or he dissolves by heat any ordinary soft soap in the borax solution, and incorporates the same, after which the mass is allowed to cool in the usual manner.

Camphor and Ammonia Soaps.—Messrs. Cooper and Smith introduce these substances into ordinary hard or soft soap, the former being previously melted. The camphor is first dissolved in camphine or rectified oil of turpentine, or in alcohol. The solution of camphor is added to the hard or soft soap in any desired quantity according to the use to which it is to be applied. The carbonate of ammonia is first reduced to a fine powder, and this is well incorporated with the soap by stirring. The carbonate of ammonia is added in the proportion of from one to five parts by weight to every 100 parts of soap. The addition of camphor to the soap is said to give it valuable disinfecting properties, while carbonate of ammonia increases the detergent power of the soap. The camphor may be used without the carbonate of ammonia, and the latter without the former, or they may both be added to the same soap.

In addition to the camphor solution and carbonate of ammonia, the patentees prefer to add of borax about 10 per cent. to the soap, and also glycerine to the extent of 5 per cent. In adding borax it is dissolved in as small a quantity of water as is practicable, and the solution is

added to melted hard soap. In treating soft soap the camphor and ammonia may be added either singly or conjointly, and with or without borax and glycerine. The borax may either be added in solution or in fine powder. In making soft soap for ships' use 2 per cent. of tar is added to soft soap in addition to the other ingredients, the tar being first dissolved in pyroxylic spirit.

Mackay and Seller's Process.—The patentees' process consists in mixing with soap, during its manufacture, chlorate of potash "or any other substance which, in process of solution in water, will give off oxygen." The chlorate of potash is sifted into or mixed with the soap "on the point of its setting, or just before it is allowed to cool, in such manner that the oxidizing agent is not then dissolved in such soap base, but preserved therein more or less in contact with the soaps treated. The object of introducing the chlorate, or other oxidizing agent, is to facilitate the removal of dirt during the process of washing. Proportions: about 7 lbs. of chlorate to 112 lbs. of soap.

Petroleum Soap: Bastet's Process.—Caustic ley at 36° B. is placed in a suitable vessel, and then equal parts of animal fatty matter and mineral oil are placed in separate vessels. The combined weight of the fatty matter and the mineral oil being taken as a standard, boracic acid sufficient to dissolve the alkali is used; the mineral oil is heated to a temperature of about 90° F., and the animal fatty matter is melted by steam heat, and while in this condition a quantity of boracic acid is dissolved therein, which, with that acid used as before, will make up one-half per cent. of the combined weight of the fatty matter and mineral oil employed.

The partially acidified animal fatty matter and the mineral oil being heated in separate vessels, are now united by gradually pouring the former into the latter, with constant stirring or agitation, in order to effect a perfect combination; the acidified alkali is then gradually added, and the mass kept well stirred.

The process of converting the mineral oil into a solid is completed by gradually adding the ordinary or un-acidified alkali in sufficient quantities to effect this result, keeping up the agitation as before. When the entire mass is found to be granulated, the conversion into a saponaceous compound is complete. While animal fatty matter only has been mentioned, the same results can be reached by the use of vegetable fatty matter, or a mixture of animal and vegetable fatty matters. The soap is finished by the free use of steam. Liquefaction is accomplished by a jet of steam to thoroughly deoxidise the saponified matter and disintegrate the compound. After the use of steam for this purpose, the soap is boiled by superheated steam.

Besson and Remy's Process.—This consists in forming a soap paste of any ordinary ingredients, and perfuming as desired. The soap is afterwards pulverised, as in making shaving powder, and the powder thus obtained is agglomerated by pressure in small moulds of special form, that is to say, of a form corresponding to that required in the pieces. This form is in section plano-concave, so that the middle portion is comparatively thin, and can be crushed by the finger with a very slight pressure applied to the flat side. The crushed piece, as it consists of agglomerated powder, at once becomes disintegrated, and forms a good lather in water, an effect which cannot be obtained from an equal-sized piece of ordinary toilet soap without much friction.

Tardani's Process.—Any convenient quantity of oil or suet or other fatty matter is taken, and placed in a flat-bottomed boiler of iron, constructed in the form of a truncated cone, together with double the quantity of water and a proportion of quicklime previously slaked by a quantity of water equal to 12 per cent. of the weight of the oil or fat. The whole must be boiled and mixed by means of an agitator—a mechanical one by preference.

This will produce an insoluble hard lime soap and a solution of glycerine, the latter of which may be separated by opening the top of the perforated pipe connected with

the bottom of the boiler. After having washed the lime soap a little and closed the top, a certain quantity of water is added to the soap, and also a quantity of commercial carbonate of soda equivalent to and rather in excess of the quantity of lime used.

When the ingredients are well mixed and the mixture boiled, the hard insoluble lime soap will be decomposed, and the lime precipitated in the form of a granular carbonate, while a soluble soda soap or potash soap (where potash is used to form a soft soap) is produced, which floats in the shape of flakes on the top of the water, more especially if sea-salt has been added. This is the reason why the shape of the truncated cone is preferred for the boiler and its bottom flat. The heat is applied only round the boiler. In this way it is said to be possible to make good soap, using fatty matter with membranes and very impure oils without incurring the expense of extracting the pure fat or oil. If cocoa-nut oil or palm-oil are to be saponified, a quantity of lime equivalent to the fifth of their weight can be used. These soaps being very soluble, even in salt water, it is necessary to use tolerably pure carbonates of the alkali.

Half-resin Soap, by Higgins's process, is produced as follows:—For a cheap laundry soap is taken prime tallow or equivalent fat, 10,000 lbs., which is saponified as usual with caustic soda of, say, 30° strength. After the first or "grease" charge an equal quantity, viz. 10,000 lbs., of clear resin is added and saponified in the usual manner. About 6,000 lbs. of caustic soda at a strength of 30° is used for the whole. Upon the completion of the saponifying process, and while the compound is in a hot fluid state before framing, a quantity of crystallised stearic acid of commerce, equal in amount to about 2 per cent. of the whole mass, is added, or about 3 per cent. of stearine, the substance in either case being in a melted state. This is added gradually while the soap is hot and is thoroughly "crutched" into the body, which is then "framed" in the usual manner. The mass solidifies into a hard and useful soap, having in its composition equal portions of

resinous and fatty matter, instead of only one-third or one-fourth as usual.

This soap is said to preserve its quality and hardness better than ordinary resin soaps, does not become unduly dry and brittle, and also possesses the advantage that while in most laundry soaps a large portion is wasted because of their extreme solubility, which causes them to dissolve to a greater extent than is required for the strictly detersive purposes, the soap produced by the above process is said to last longer, besides being also cheaper.

Mr. G. Payne's Process consists in treating fatty or oily matters and subjecting the same, under pressure, in an autoclave with lime and water.

After the decomposition of the fatty or oily matter in the autoclave, the aqueous solution of glycerine is withdrawn, and instead of decomposing the lime soap with acids, as in the ordinary process of making stearine, the inventor employs for its decomposition strong caustic soda or potash leys, or a solution of carbonate of soda or potash. The hydrated or carbonate solution is used in about the proportion of 7 per cent. of the alkaline base to from 60 or 70 per cent. of the fatty acid, these proportions being varied within certain limits; in all cases care must be taken that the alkali shall be sufficient to combine with or saturate the whole of the fatty acid. The decomposition of the lime soap by means of the hydrate or carbonate of soda will result in the production of a soda soap, and where the hydrate or carbonate of potash is used for such decomposition the product will be potash soap, the lime in either case being precipitated in a more or less insoluble condition. The soaps obtained by this process may be finished in a soap-copper in the ordinary manner.

Mr. Bankmann's Process has for its object to furnish soap in the form of thin perforated sheets or tablets, so that a single piece may be torn off for each washing of the hands or face. A number of frames are placed one above another, and are securely fastened together in such a manner that the joints are water-tight. The soap to be treated is put

into these frames, and the sides or sections are capable of being removed so as to leave the soap projecting. Thin shavings are planed from the block of soap by a cutter passing along the surface, and the shavings or sheets are then subjected to the action of a roller which compresses and smooths them. Then a perforator divides each shaving or sheet into correspondingly small pieces. Each sheet should be about 3 inches long by 2 inches broad, and perforated crosswise so as to form four tablets. The sheets have then about the thickness and portability of postage-stamps. About one dozen of such sheets may be arranged in a packet in form of a pocket-book. The packet will then contain the material for forty-eight separate washings. If desired, the soap may be impregnated with carbolic acid, tar, or other medicinal material.

Mr. W. Jeyes's Process.—The inventor introduces anthracine salt, naphthaline, or any similar crystallisable hydrocarbon into the ordinary ingredients of soap. Either of the above salts is added to and mixed with the ordinary ingredients of soap at any convenient period during the manufacture before solidification, and in various proportions, according to the use to which it may be intended to apply the soap.

M. Varicas's Process.—"The practice now," says the inventor, "is to saponify fats with alkalies without any previous treatment of the fat, looking to the preliminary decomposition of the same. The result is a comparatively slow saponification, and all the glycerine which does not remain in the soap mechanically suspended is carried off in the waste ley and lost. The object of this invention is to prepare fats for instant saponification, and to save all the glycerine. To effect this, the inventor first extracts the glycerine from fats in their neutral state by the direct action of steam and water, under a pressure of about 150 lbs., whereby a soap stock is produced susceptible of immediate saponification when combined with an alkaline ley. Besides the important advantage of saving all the glycerine, the whole process of soap-making is said to be materially hastened, and the resulting soaps are of superior

quality, all things being equal, than soaps made by ordinary methods.

Lorbury's Process consists in adding a solution of gluten in caustic alkali to soap, by which the emolliency of the soap is said to be considerably increased. The gluten may be added to any kind of soap after the process of saponification is complete. The solution of gluten is thus obtained:—To a solution of caustic potassa of about 20° B. as much bran or gluten obtained from any other source is added as it will take up. After some hours' digestion the mass becomes clear and homogeneous, when it is strained through a fine sieve or coarse cloth. This solution is added to the soap to the extent of 10 per cent. more or less.

Cleaver's Terebene Soap.—Mr. Cleaver combines with soap while in a melted state the substance known as *terebene*, whereby a disinfectant and antiseptic soap is produced. This substance is also combined with toilet creams, cosmetics, &c. The following proportions, which may, however, be varied at will, are said to give good results:—For toilet soap 4½ pints of terebene are added to 112 lbs. of soap. For household or laundry soap, he adds 6 pints of terebene to 112 lbs. of soap. The terebene is introduced into the soap in its liquid state, and thoroughly incorporated by stirring. The soap may be perfumed if desirable. The soap is known as *terebene soap*.

Scharr's Liquid Soap.—For making this soap the following complicated formula is given for one ton of the compound:—

Twelve cwt. of water and 4 lbs. of starch are first boiled together for a few minutes, after which the following ingredients are introduced:—

Linseed	53 lbs.
Sal ammoniac	8 ,,
Soda ash (52° to 54°)	44 ,,
Pearl ash (American)	56 ,,
Russian potash	73 ,,
Resin	52 ,,
Oleine	26 ,,
Borax	4 ,,
Spirit of turpentine	5 ,,
Liquid ammonia	10 ,,

The ingredients are placed in a vat or other suitable vessel, and boiled by injection of steam for two hours. The liquid, after being boiled, is passed through a sieve, to separate the solid portion; it is then cooled down to between 90° and 122° F. The solid or third portion is put into a cask (which is provided with a tap near the bottom) and upon it is poured about 40 to 44 gallons of boiling water, which is thoroughly incorporated by stirring. It is then allowed to rest until it becomes clear, when the clear portion is run out by the tap into a suitable receiver, and brought to the boiling-point by the injection of steam. The steam is now turned off, and 152 lbs. of soft soap and 20 lbs of American pearlash are added, with stirring. The soap which had previously cooled down is now introduced and well mixed by stirring, when the compound is ready for use.

Mr. Bichford introduces powdered French chalk (steatite, or soapstone) into soap, employing from 4 to about 7 per cent., according to the purpose for which the soap is to be used. For a nursery soap, 4 per cent. is recommended, and for toilet soaps 5 per cent. of the powder.

As far back as 1838 Mr. Sheridan—the original inventor of silicated soaps—patented a process for combining potato flour, water, and soda or potash leys (preferring the latter alkali) in the following proportions:—potato flour, 16 lbs.; water, 270 lbs.; potash leys, 100 lbs. It will be seen, as is too frequently the case with "improvements" in soap, that the same idea has been often patented since.

Marking Soaps.—Mr. Dunn suggested marking soaps, coloured soap, or other similar material in this way:—The soap is first stamped in the usual manner, and when dry the impression is filled in with plastic soap of a different colour by means of a spatula; or if the impression is fine and small, with dry powdered and coloured soap, by means of a spatula, with which a little of the powder is spread over the impressed surface.

CHAPTER XXIV.

ALKALIMETRY. METHODS OF DETERMINING THE PERCENTAGE OF REAL ALKALI IN COMMERCIAL SODA ASH, POTASH, AND CAUSTIC ALKALI.

Mohr's Alkalimeter.—Preparation of the Test-Acid.—Sampling Alkalies. —The Assay. —Normandy's Method.—Testing Commercial Pearlashes.—To determine the Percentage of real or anhydrous Alkali.

It must be obvious that in a manufacture which consumes vast quantities of materials of variable quality, some means of estimating the *actual* value should be at the command of the consumer. The science of chemistry, which, as we have shown, rescued the art of soap-making from the empiricism and ignorance which ruled its operations until little more than forty years since, has shown not only the principles of saponification, but also the means by which the precise value of the various ingredients employed in the art may be determined with absolute certainty, and with comparative ease and simplicity.

It was the custom formerly for the soap-boiler to estimate the strength of his alkali by first pouring a quart of water on a pound of the ash, and then putting into the solution a lump of Dutch soap, which floated in it; he then added more water gradually until the piece of soap sank, and the more water that was required to effect this object, the richer in alkali was the ash supposed to be. It is needless to say that a test of this kind would be all but worthless.

The first adoption of a system for estimating the relative value of alkalies by chemical agency was made by the celebrated French chemist Vauquelin; this was followed by Descroizelles' important invention of the *alkalimeter*, by the aid of which tolerably accurate results could be obtained.

To our own countryman, Dr. Andrew Ure, however, we are indebted for the employment of a test-acid that represents the absolute amount of alkali in a given commercial sample of soda or potash, whether in the form of carbonate or of caustic alkali. To understand the methods of determining the percentage of real alkali in a commercial sample it may be necessary to refer briefly to the laws of chemical combination defined by the atomic theory of Dr. Dalton. This great chemist discovered that all substances combine in *definite proportions* or equivalents; for example, 1 part by weight of *hydrogen* combines with 8 parts of *oxygen* to form water. The *equivalent number* of hydrogen, therefore, is 1, that of oxygen 8, and that of water 9. Again, 3 equivalents of oxygen combine with 1 equivalent of sulphur (16) to form sulphuric anhydride, thus: sulphur 16, oxygen 24, equals anhydrous sulphuric anhydride 40, or monohydrated acid (strong oil of vitriol) 49; therefore, 49 is the *equivalent* or combining number of this acid, and it cannot be made to unite with alkalis or other bases in any other proportion. For example, *forty-nine grains* by weight of *pure* sulphuric acid will neutralise exactly 53 grains of *anhydrous carbonate of soda*, 31 grains of *pure anhydrous* soda (sodic oxide), or 40 grains of *hydrate of soda* (caustic soda). This being so, it is only necessary to have exactly 49 grains of *pure* sulphuric acid in 1,000 grains of water to form a *test-acid*, which, when employed to neutralise an alkaline solution, will show, by the proportion of dilute acid used to saturate the alkali, the absolute percentage present in the sample.

There are two principal methods of analyzing or assaying alkalies by means of the test-acid, the first of which is *volumetric*, or by measure; and the second *gravimetric*, or by weight. In the former, the test-acid or "standard solution" is applied by means of a glass vessel termed an *alkalimeter*, or *burette*, which holds, up to its 0 or *zero* mark, exactly 1,000 grains The scale is graduated into 100 divisions, which are again subdivided into tenths. There are several forms of the burette or alkalimeter, all more or less admirable for their ingenious

construction, but for the ordinary purposes of alkali testing Bink's burette, Fig. 33, or Mohr's burette, Fig. 34, will be well suited to the soap-maker's laboratory. The simplicity of the former at once commends it, but the latter has the advantage of enabling the operator to add the test-liquor drop by drop, when the alkaline solution is near the point of saturation, without encumbering the hands.

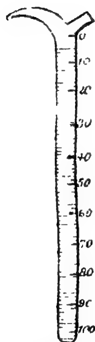


Fig. 33.

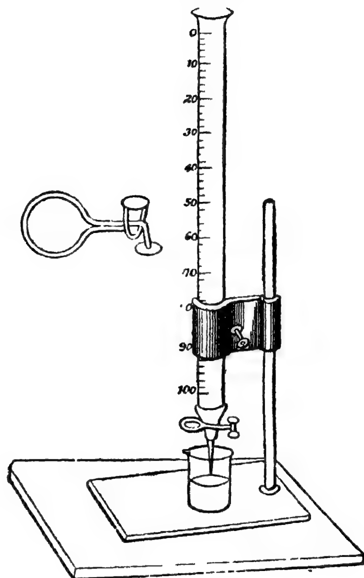


Fig. 34.

Mohr's Alkalimeter.—Mohr thus describes the construction and use of his very useful and ingenious apparatus.* "I have succeeded in substituting for expensive glass stop-cocks, an arrangement which may be constructed by any person with ease, which remains absolutely air and water tight for an indefinite period, which may be opened and regulated at will by the

* *The Chemist*, vol. i., New Series, p.158.

pressure of the fingers, and which costs almost nothing. It consists of a small piece of vulcanised india-rubber tube, which is closed by a clamp of brass wire (Fig. 34). The ends of this clamp, which I call a pressure-cock, are bent laterally at right angles in opposite directions, and furnished with knobs, so that when both ends are pressed the clamp is opened, and a single drop or a continuous current of liquid may be allowed to escape at pleasure. The measuring tube is a straight glass cylinder B, as uniform as possible, graduated into 0·2 or 0·1 cubic centimetres, and somewhat contracted at its lower end, so as to fit into the india-rubber tube. A small piece of glass tube, inserted below the pressure-cock, forms the spout. The pressure-cock has the advantage of not leaking, for it closes of itself when the pressure of the fingers is removed.

"The measure furnished with the pressure-cock is fastened upon an appropriate stand, which can be placed at any required height. When used, it is filled above the zero point with test-liquor, the cock opened for an instant, so as to let the air escape from the spout, and the level of the solution is then adjusted. This is done by bringing the eye level with th zero point, and applying a gentle pressure to the cock il the liquid has sunk so low that the inferior curve ot he liquid touches the graduation like the circle of a tangent; the cock is then closed, and at the same moment the liquid remains at zero, and continues to do so for weeks, if evaporation is prevented. The test measure being now normally filled, the experiment may be commenced; this is done sitting, while the filling of the measure is done standing.

"The weighed sample of alkali is first placed in a 'beaker' glass, and the test-liquor is allowed to flow into it by gently pressing the cock. Both hands are set at liberty, for when the pressure-cock is released it closes of itself. The volumetric operation may be interrupted at pleasure, in order to heat the liquid, shake it, or do whatever else may be required. The quantity of liquid used may be read off at any moment, and in repeating an ex-

periment the limit of the quantity used before may be aproached so near that the further addition of liquid may be made drop by drop."

When alkalies are analyzed *gravimetrically* a *specific gravity-bottle* (Fig. 35) capable of holding exactly 1,000 grains of distilled water is employed, and this, when filled with test-liquor, weighs (exclusive of the *tare* of the bottle) exactly 1·033 grains. 1,000 grains of the test-liquor contains exactly 49 grains of *real* sulphuric acid. The test-acid to be used *volumetrically*, that is, with the alkalimeter, has a specific gravity of 1·032 at 60° F., and 1,000 grains *by measure* contain exactly 49 grains of real or anhydrous sulphuric acid.

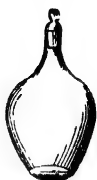


Fig. 35.

Preparation of the Test-acid or Standard Solution.—When making the test-liquor it is advisable to prepare a quantity sufficient for many operations, since there is necessarily a certain amount of trouble involved in its preparation. It may be readily made by mixing 1 part of concentrated sulphuric acid with 11 or 12 parts of *distilled water*, the mixture being effected in a "Winchester" bottle, which holds rather over half a gallon. The acid solution must be *adjusted* or brought to the proper strength after it has cooled down to 60° F., and it should be *faintly tinged* with litmus, which will give it a pinkish hue.

If the acid is of the proper strength it should *exactly* saturate 53 grains of pure carbonate of soda previously calcined at a red heat, or 31 grains of pure anhydrous soda. To prepare the anhydrous carbonate of soda, place a few crystals of carbonate of soda in a Berlin porcelain crucible, and heat this over a spirit-lamp or Bunsen burner; when all the water of crystallisation is expelled continue the calcination until the mass is at a bright red heat, when the vessel may be set aside to cool. Now carefully weigh out 53 grains of the calcined carbonate, and dissolve in about 2 ounces of distilled water in a beaker-glass. The alkalimeter is now to be charged with the test-acid to the level of zero, and (if Mohr's burette be used) the beaker containing the alkaline solution is to be placed upon the

stand immediately beneath the exit-tube. Now press the nobs of the pressure-cock, and allow a portion of the liquor to flow into the beaker. When the effervescence which is immediately set up subsides, make further additions of the test-liquor from time to time, until the effervescence becomes sluggish, when the acid must be added with greater caution. When the solution approaches saturation it acquires a purplish tint (due to the litmus with which the acid is tinged), which it retains until the point of saturation is reached, when it suddenly changes to *pink* or onion-red colour. After each addition of the acid the solution should be stirred with a thin glass rod, and before the final change from purple to pink or onion-red, the end of the glass rod should be applied to a strip of blue litmus-paper, when, if the spot touched assumes a red colour, the saturation is complete; if, on the contrary, the paper is unchanged, or has a violet or reddish hue, add the test-liquor, one or two drops at a time, with continued stirring, until a drop of the solution applied with the rod reddens the litmus-paper, when the saturation is finished. If any test-liquor remain in the burette this indicates that there is an excess of acid in the test-liquor; consequently more distilled water must be added to the bulk, the burette emptied and refilled with the reduced liquor, and another 53 grains of anhydrous carbonate treated as before, until 1,000 grains of the acid liquor *exactly* neutralise the solution. Should the whole contents of the burette in the first trial be used before saturation is complete, a little more sulphuric acid must be put into the Winchester or test-acid bottle, and a 53-grain solution of carbonate of soda treated as before. A very little practice will enable the operator to adjust his test-liquor with perfect accuracy; and, in order to prevent mistakes, the bottle should be labled "Test-acid," and should be kept closed with its glass stopper.

Sampling Alkalies.—The ordinary soda ash of commerce is usually packed in wooden casks; and in order to secure a fair average sample from a large number of these casks, which may represent one consignment, it is important

to take small samples, as near the centre of each cask as possible, from as many of the casks as time will permit. Each sample, as drawn from the cask, should be at once placed in a wide-mouthed bottle furnished with a well-fitting cork. Each sample should be numbered and marked with the brand which distinguishes each cask. The soap-maker who tests or assays his own alkali should always be careful to employ a person of known intelligence and integrity to procure samples for him.

When about to analyze any given sample, first empty the contents of the bottle upon a piece of dry paper, then crush the larger lumps, and reduce the whole to a coarse powder as quickly as possible, so as to prevent absorption of moisture from the atmosphere. Now carefully weigh out 100 grains, and put them into a small flask (Fig. 36), and at once return the remainder to the bottle, and securely cork it. Pour into the flask about half an ounce of distilled water, and gently heat it, shaking occasionally to assist solution of the alkali. After a few minutes set the flask aside to enable the insoluble matter to subside, then pour *the clear liquor* into a beaker-glass, and wash the sediment several times with small quantities of distilled water, being careful to add the washings to the alkaline solution in the beaker. This washing must be performed several times, or until the last washing-liquor produces no effect upon yellow turmeric-paper. So long as the washings give a brown tint to this test-paper the presence of alkali is assured, and the washing must be continued. It is important, after each washing, to pour off the last drop of the liquor, by which the process is rendered more complete and with less water than when this precaution is not observed. To ensure perfect accuracy every particle of the washings must be added to the contents of the beaker-glass in which the assay is to be made.


Fig. 36.

The Assay.—To perform the assay, the alkalimeter must first be filled with the test-acid exactly to the line 0 or zero of the scale; the acid must then be allowed to

flow gradually into the alkaline solution (which should be constantly stirred with a glass rod) until the liquid assumes a purple tint, which it retains until the exact point of saturation is reached, when it suddenly changes to pink. It is commonly the practice to warm the alkaline solution so as to expel the carbonic acid which is evolved and absorbed by the solution during the process of saturation. When the neutralisation is complete, the alkalimeter is allowed to repose for a few moments, so that the acid liquor may drain from the interior of the glass into the bulk of the fluid, and the quantity of test-acid used is then determined by reading off the number of divisions which have been exhausted.

Every alkalimeter division of Mohr's burette (Fig. 34) represents $\frac{1}{100}$th part, or 1 per cent., of alkali, when 100 grains are taken for assay.

"In *commercial assays*, when 100 grains (or some aliquot part thereof) are taken for trial, the *percentage* result is obtained from the number of *alkalimeter divisions*, or the number of grains of the test-acid consumed by the common 'Rule of Proportion.' Thus: A *crude sample* of potash, having taken 90 alkalimeter divisions of test-acid to neutralise it, would contain—

$$100 : 47 :: 90 : 42{\cdot}30$$

or nearly $42\frac{1}{3}$ per cent. of pure potassa. If only 50, 25, or 20 grains are tested, the result must, of course, be *double*, *quadrupled*, &c., as the case may be. Or the *third term* of the proportion may be *multiplied* by the *denominator* of the *fraction* representing the aliquot part. This, in the case of 50 grains (repeating the above example), would be—

$$100 : 47 :: 45 \times 2 : 42{\cdot}30\frac{0}{0}$$

as before; but even these easy calculations may be simplified, as is shown below.

"One of the advantages, and not the least, attending the use of test-acids corresponding to equivalents is that, by means of the simple 'Rule of Three,' the *percentage*

quantity of alkali may be found, whether 100 or any other number of grains have been submitted to trial. For *the weight of the sample tested* (in grains) bears the same relation to the *equivalent weight of the alkali under examination*, that the *number of alkalimeter divisions* or of the *grains of test-acid consumed* do to the *percentage of alkali sought*. Thus, with a sample of 33 grains of *pearlash*, taking 35 *alkalimeter divisions* or 350 grains (every 10 grains being = 1%) of test-acid for neutralisation This would be—

33 : 47 :: 35 : 49·85%

or nearly 50 per cent. of *pure potassa*. By substituting the equivalent of the *dry carbonate of potassa* (69) for that of 'pure potassa' used above, the quantity of that article corresponding to the same weight of the pure alkali may be at once found. Repeating the last example this will be—

33 : 69 :: 35 : 73·18%

or nearly 73¼ per cent. The same applies to all the alkaline bases and their carbonates."—*A. J. Cooley.*

The following table shows the *equivalent* or combining proportions of alkalies with 49 grains of real (that is, anhydrous) sulphuric acid :—

		grs.
49 grains of anhydrous sulphuric acid	Are equivalent to	47 Potassa (anhydrous)
1,000 grains of dilute sulphuric acid (sp. gr. 1·033)		56 Hydrate of potassa (pure caustic potash)
1,000 grains (water-grain measure) sp. gr. 1·032		69 Carbonate of potassa (anhydrous)
		31 Soda (anhydrous)
		40 Hydrate of soda (pure caustic soda)
		53 Carbonate of soda (anhydrous)
		143 Crystallised carbonate of soda.

Normandy's Method.—Dr. Normandy gives the following method of assaying commercial soda and potash* :—

* "Commercial Handbook of Chemical Analysis." By A. Normanby. Lockwood and Co.

"*Commercial Soda.*—Five hundred grains are weighed out from the thoroughly powdered and mixed sample. After being dried it should be gently ignited in a porcelain or platinum crucible, and allowed to cool without exposure to the air. When cool it is again weighed; the loss indicates the amount of moisture. It is then washed into a beaker, in which it is dissolved. Should any insoluble residue remain it is filtered off, dried, and weighed; the clear filtrate is made up [with distilled water] to exactly 10,000 grain measures. The solution is well mixed together, and from it 1,000 grain measures are taken, transferred to a beaker, the solution made blue by a few drops of litmus water, heated nearly to boiling, and then tested with the normal acid [or standard test-acid] until the neutral point is reached; the process may be repeated several times, if necessary, to be certain of the accuracy of the analysis. In order, however, to avoid all ambiguity arising from the carbonic acid, a sufficient quantity of acid may be added to render the acid very decidedly red, and then the normal caustic alkali* added drop by drop until the liquid changes suddenly to violet-blue. The number of divisions of the burette that have been required to effect this must be deducted from the quantity of acid originally used. By this *backward* or residual method very sharp results may be obtained.

"*Example.*—Suppose 850 burette divisions of the normal acid have been required, the following calculation gives the amount of real carbonated alkali in the sample:—

$$1{\cdot}000 : 850 :: 53 : x$$

$x = 45$, the amount of carbonate of sodium in 53 grains of the sample.

"The soda ash of commerce contains generally, besides

* The normal caustic alkali solution is prepared by dissolving exactly 56 grains of hydrate of potassa (pure caustic potash), or 40 grains of hydrate of soda (pure caustic soda), in 1,000 water-grain measures of distilled water. The solution is applied from a burette.

insoluble substances, which are removed by filtering, a greater or less quantity of chloride of sodium (common salt), and of sulphate of sodium (which, however, do not interfere with the accuracy of the result); but when sulphurets, sulphites, or hyposulphites are present, these substances, neutralising a certain quantity of the test-acid, would render the estimation seriously inaccurate; wherefore it is absolutely necessary in such cases to transform these substances into *sulphates* by calcining a given quantity of the sample with 5 or 6 per cent. of chlorate of potassium, as recommended by Gay-Lussac, and Welter."

The chlorate of potash is first pulverised, and then 5 or 6 grains are intimately mixed with each 100 grains of the sample, and the mixture is fused in a platinum crucible. When cold, the fused mass is dissolved in boiling water, filtered and washed, and the assay then conducted in the same way as before described. If, however, the soda ash contains any *hyposulphites* this method must not be adopted, since each equivalent of hyposulphite would be converted into *two* equivalents of sulphate, at the expense of the alkali or its carbonate present in the sample, and which would render the assay seriously inaccurate.

MM. Fresenius and Will, in order to overcome this source of inaccuracy, recommend the addition of a small quantity of yellow chromate of potash to the alkaline solution, by which the sulphurets, sulphites, and hyposulphites are converted into *sulphates, sulphur*, and *water*. Fresenius says: "It is always advisable to make it a rule, in the examination of *soda*, to add some chromate of potassa."

Testing Commercial Pearlashes is performed in the same way as samples of soda, but it is usual to employ a separate test-acid for this purpose. The test-acid for potash should have a specific gravity of 1·070 to 1·071; 470 grains contain 49 grains of *real* sulphuric acid. Of this solution 1,000 grain measures (or 100 burette divisions) *exactly* neutralise 113 grains of pure *anhydrous carbonate of soda*, or exactly 100 grains

of pure potassa. The number of measures consumed read off, by *mere inspection*, from the burette scale, gives the exact percentage of the sample of potash under examination. Or, if Normandy's method be adopted, "as the equivalent of carbonate of potassium is 69, the weight of the sample to be operated upon to make in solution 10,000 grain measures will be 690. It may sometimes be convenient to employ a normal sulphuric acid, 1,000 grain measures of which shall be equivalent to precisely 100 grains of the anhydrous caustic alkali. For this purpose it is obvious that different standard acids will be required for soda and for potassa. That for soda must be of such a strength that 1,000 grain measures shall saturate exactly 171 grains of pure carbonate of sodium, and that for potassa must be precisely equivalent to 146·8 grains of pure carbonate of potassium. The advantage of the standard above described is its equivalency both to potassa and soda."

There are many other methods of determining the percentage of real alkali in the commercial products than those referred to, but to enter into this subject more fully would involve more space than the limits of this work would permit. Since, moreover, soap-makers are now supplied with caustic soda, as also caustic potash, the necessity for testing soda and potashes is greatly diminished.

To determine the percentage of real or anhydrous alkali in a sample of caustic soda or potash, M. Barreswill recommends the following method: "A solution of *chloride of barium* is added in excess to a solution of the sample under examination, and the whole is filtered; the precipitate of carbonate of baryta left on the filter is washed with a little water, and the *filtrate* and the *washings* placed in a deep glass tube; a stream of carbonic acid gas is then passed through the mixed liquor until it ceases to occasion a precipitate of carbonate of baryta. This last precipitate is separated on a filter, washed, dried, and weighed. Each grain represents ·315 grains of *real or anhydrous soda*; or ·477 grains of anhydrous potassa."

Ure says: "Add the *first* portions of the test-acid very gradually to the sample, carefully observing the effect. When the effervescence at length commences, *the weight* or measure of the test-liquor expended shows the quantity of pure *caustic alkali* under treatment (nearly). The result depends upon the fact that little or no carbonic acid gas is expelled from the liquid on the addition of the test-acid until the caustic portion is *very nearly neutralised.*"

CHAPTER XXV.

METHODS OF ANALYZING OR ASSAYING SOAPS.

Soap Assay.—Rampel's Method.—D'Arcet's Method.—Richardson and Watt's Method.

It is of the greatest importance to the soap-maker that he should be able to estimate the exact proportions of fatty matter, alkali, and water in each boil of soap when finished and ready for sale, in order that he may determine the cost of manufacture and estimate his profit. A simple method of assaying a sample of soap is the following :—

Soap Assay.—I. *To estimate the percentage of water*, take a *fair* sample, say from a recently cut bar of soap,* and weigh 100 grains. Cut this into thin slices or shavings, and put them into a small porcelain capsule, which is then to be placed over a water-bath kept boiling, or over an oil-bath heated to 350° F., until the shavings are quite free from water, in which condition they are exceedingly brittle. The shavings should be weighed from time to time, or until they cease to lose weight by continued heating. The ultimate loss in weight indicates the percentage of free or uncombined water, which, in the case of curd and mottled soap, should not exceed 35 per cent.† The loss in yellow or resin soap would be about 45 per cent., and in Castile or olive-oil soap about 14 or 15 per cent.

II. *To estimate the combined fatty acids*, dissolve 100 grains of the soap to be examined in 4 or 5 ounces of boiling distilled water in a porcelain capsule, then add a little hydrochloric acid, and stir gently. The acid, com-

* If the soap has dried on the surface, the sample should be taken from the interior of the bar.

† Ure gives the following analysis of London curd soap :—Fat, 52 ; soda, 6 ; water, 42 = 100.

bining with the soda, will set free the fatty acids, which will float on the surface. Now set the vessel aside to cool, and, when quite cold, make a hole in the cake of fatty matter, and allow the liquid to escape into another vessel. To hasten the solidification of the fatty acids, add 100 grains of white wax and a little water, and then apply heat until the whole is well melted; again set aside to cool, and proceed as before, washing the cake several times until no trace of acid remains in the last water when tested by litmus paper. Finally, run off all the water, remove the cake carefully, and place it upon a piece of white blotting-paper and thoroughly dry it, taking care not to allow any particles of the combined fatty matter and wax to remain in the capsule. After carefully weighing and deducting the 100 grains of wax, the result will show the proportion of fatty acids in the sample of soap under examination. If, when the soap is first dissolved in boiling water, oily matter floats on the surface, it indicates that saponification has not been complete.

III. *To ascertain the percentage of alkali.* This may be effected roughly by simply volatilising all the fatty matter by heat, and then weighing the residuum. Having weighed out 100 grains of the soap, place them in a porcelain crucible and apply heat either over a clear fire or a Bunsen burner until all the fatty matter has burnt off, when the residuum, which is carbonated alkali, will show, on weighing, the percentage of alkali in the sample. If the soap, however, has been adulterated with earthy matters, as silicate of soda or china clay for example, the proportion of real alkali must be determined by the alkalimetric test before described. 100 grains of the soap being dissolved in about 2,000 grains of boiling water, the solution is then neutralised with test-acid, and the quantity of this acid used will give the exact percentage of alkali present in the soap.

"If the soap contain clay, chalk, silica, dextrine, fecula, pumice-stone, ochre, plaster, salt, gelatine, &c., dissolve 100 grains of the suspected soap in alcohol; with the aid

of gentle heat the alcohol will dissolve the soap and leave all these impurities in an insoluble state. Good mottled soap should not leave more than 1 per cent. of insoluble matter, and white or yellow soap less still. All soap to which earthy or silicious matter has been added is opaque instead of being transparent on the edges, as is the case with all genuine fitted soap. The drier the soap the more transparent it is."—NORMANDY.

There is no better test for insoluble impurities than dissolving a given weight—say 100 grains—of soap in alcohol.* After the insoluble matters have subsided, the clear solution should be poured off, and the residual matter washed several times with alcohol, after which it should be carefully dried and weighed.

To determine the nature of the fatty matters which have been used in the manufacture of soap is a difficult and sometimes a very laborious task. An approximate result may be obtained, however, by first saturating an aqueous solution of the soap with a solution of tartaric acid; the fatty acids which float on the surface may, when cold, be transferred to a porcelain capsule, and heated gently over a water-bath. By applying a thermometer, the *fusing point* will give some idea of the nature of the fatty material, as to whether the soap was made from tallow or oils, or a combination of both. Again, if the fatty acids have been separated by dilute sulphuric or hydrochloric acid, if a little be rubbed in the palm of the hand the odour will frequently indicate the nature of the fatty material.

Soft soaps are assayed in the same way as hard soaps, but the manipulation is somewhat more troublesome, and therefore involves a little extra caution.

Unsaponified Fatty Matter.—A properly-made soap is *entirely* soluble in water. If, therefore, after a sample of soap has been dissolved in hot water and allowed to rest for awhile a film of fatty matter appears on the surface (and which makes a greasy stain upon paper), that portion of the fat has not been saponified.

* Good methylated spirit answers equally well, and is much cheaper than alcohol.

Since pure soap is entirely soluble in alcohol, any insoluble colouring matter which may have been introduced into the soap may readily be separated, and, if desirable, examined by ordinary chemical tests.

Rampel's Method of Assaying Soaps.—1. The analysis of soaps does not present any more difficulty, and may be done in as little time and with as much precision as that of alkalies. 2. There is no necessity for analyzing marbled soap, for it *cannot be adulterated*; an excess of water would precipitate the marbling, and the introduction of foreign substances would prevent its formation. 3. For the white or unicoloured soaps, *i.e.* manufactured according to the Marseilles method, the quantity of water is determined by the usual process. The soap in thin shavings is submitted to a temperature of 212° F. The soap is weighed before and after drying, the difference in weight giving the proportion of water. One drachm dissolved in 2 ounces of hot water indicates, by the limpidity of the solution, if the soap has been manufactured by *liquefaction.* If the solution is muddy, this effect is due to the presence of resin. Liquefied soaps do not require further analysis, for they can contain neither insoluble nor inert substances. 4. Unicoloured, white, or other liquefied soaps mixed with resin, manufactured by saponification and evaporation, always produce muddy solutions. 5. To ascertain the presence and quantity of insoluble substances contained in soap, the process is simple and easy. Introduce into a small test-tube a few grains of soap, and heat it with about ten times its weight of alcohol. The solution is soon completed if there is no insoluble impurity; if, on the contrary, a deposit is left, it is to be well washed several times with alcohol, and weighed after drying. Its weight indicates the quantity of insoluble substances in the soap.

When the proportion of water and insoluble matter has been ascertained, the operator has approximately determined the value of the soap. Indeed, if the soap has given 30 or 34 per cent. of water, and 1 or 2 per cent. of insoluble matter, it is certain that the soap contains 6

per cent. of alkali, and 60 per cent. of fatty acids, which are the constant proportions of the marbled and pure white liquefied soaps. If, on the contrary, the proportion of water exceeds 85 per cent., or the insoluble matter 2 per cent., it is a certain proof that the soap has been adulterated. In either case it is useless to determine the proportions of fatty and inert substances that the soap contains.

By burning a small quantity of soap and assaying the residuum in the same manner as by the alkalimetric process, the real quantity of alkali and inert substances is determined at the same time. The alkalimetric assay is not necessary; indeed, when soap is burned, the residuum obtained contains all the fixed principles of the soap, but instead of having the soda in a *caustic state*, as in the soap, it exists in the form of a carbonate.

6. To ascertain the value of the soap as to the proportions of fatty acids and base it contains the following is recommended:—A given weight of soap in solution is decomposed by an acid; the fatty acids float on the surface of the liquid, and it is easy to collect them and determine their weight. When they do not collect easily, they are mixed with a known weight of white wax (previously dried) which hastens their solidification. A cake is thus obtained which, when cold and dried, is weighed, the weight of the wax used being deducted from the gross weight of the cake. To obtain the proportion of alkali, calcine a given weight of the soap in an iron ladle; all the soda becomes transformed into carbonate, and the real quantity of the alkali is determined by the alkalimetric test.

D'Arcet's Method.—If preferred, D'Arcet's system may be adopted, which consists in dissolving 2½ drachms of soap in 2 ounces of hot water; from 1 to 2½ drachms of pure and dried white wax are then added, and the whole boiled until the wax is melted, when the mixture is decomposed by the normal test-acid as in the ordinary alkalimetric process. After cooling, the weight of the fatty acids is determined by deducting the weight of wax used. By

submitting the fatty acids to pressure, the solid and liquid acids may be recognised by their consistency, odour, &c.

When the soap under examination has been made from materials rich in stearine, the addition of white wax may not be necessary, since the fatty acids will set into a hard cake. When, on the other hand, the separated acids solidify slowly, and when cold form a soft cake, it indicates that liquid vegetable oils have been employed in the manufacture.

To determine the quantity of resin in soap, Dussauce suggests the following:—One ounce of soap is decomposed by an excess of sulphuric acid. The fatty acids obtained after cooling are washed with slightly acidulated water. The cake of fatty acids is divided into small equal pieces and well dried. A certain quantity is dissolved in five or six times its weight of alcohol at 90°. When the solution is made, boiling water is added to it; the proportion of water must be larger than that of the alcohol. An immediate separation takes place. and the fatty acids float on the surface of the liquor, which becomes limpid if the soap does not contain resin, and, on the other hand, becomes milky if resin is present. After the solidification of the fatty acids by cooling, the cake is divided again into pieces, dried and weighed. The difference in weight from that of the acids before the treatment by alcohol gives the proportion of resin contained in the soap.

Richardson and Watt's System.—They give the following plan for analyzing soap:—The soap is dried over a water-bath at 212° F., and is then dissolved in alcohol (100 grains require 3 ounces of alcohol), and heated to boiling over a water-bath. The soap, resin, and free fat enter into solution, leaving the mineral constituents, glue, starch, dextrine, &c. undissolved. The liquid is filtered and the residue washed with alcohol. The alcohol is expelled from the filtrate by evaporation. Addition of water then sets free any resin or uncombined fat. These are collected on a filter, dried and weighed. The filtrate now only contains the fat soap and resin soap if any, and must be treated by

the alkalimetric test to determine the amount of potash or soda in combination with the fatty acids.

At the same time that the soap solution is decomposed, the fat and resin acids rise to the surface, and these are collected on a weighed filter, washed with hot water, dried *in vacuo*, and again weighed. The weight expresses the joint amount of fatty and resin acids in the soap. Cold alcohol will dissolve out all the fatty acid, together with a small proportion of the resin from the filter, and the filter dried *in vacuo* and weighed as before, gives approximately the amount of resin in the soap.

To determine whether the base of the soap is soda or potash, the solution of the sulphates filtered from the fatty acids is concentrated and treated with tartaric acid and bichloride of platinum in the usual way. The filter containing the matter insoluble in alcohol is dried and weighed, after being thoroughly washed in alcohol. In genuine soap this insoluble matter is of very small amount, not exceeding 1 per cent. for mottled and even less for yellow soap.

CHAPTER XXVI.

PURIFYING AND BLEACHING OILS AND FATS.

Bleaching Palm-oil: Watt's Chromo Process.—Recovery of the Chrome.—Bleaching Palm-oil with Chromate of Lime.—Purifying Oils.—Dunn's Method.—Justice's Method.

A VERY necessary branch of the soap-maker's art is that of decolouring or bleaching oils or other fatty matters previous to their introduction, with other and superior goods, into the soap-pan. The most important of all saponifiable materials possessing a colour natural to itself is *palm-oil*; but its deep orange-red colour, except for special purposes, would render it comparatively valueless as a soap-making material if there were no means of depriving it of its characteristic colour. In the early part of the present century many attempts were made to destroy, modify, or in some degree to reduce the intensity of the red colour of this oil. It was subjected to a high temperature, which changed the red to a brown tint; nitric acid was found to change the colour from red to yellow; it was subjected to the oxidising influence of the air, which greatly reduced its objectionable redness, and numerous other processes (including of course chlorine) were devised to render it serviceable as a partial substitute for tallow; but it was not until the year 1836, when Mr. C. Watt introduced his now well-known process for bleaching palm-oil by means of chromic acid, that the usefulness of this oil as a soap material could be fully enjoyed. By all the previous processes, the colouring matter of the oil, though modified, was neither removed nor actually destroyed, for it was invariably found that, in contact with caustic alkali, the colour more or less returned, and therefore affected the ultimate

colour of the soap. By the "chrome process," however, the colouring matter of the oil was entirely removed and the oil rendered as white as the finest English tallow. The importance of this process at a time when palm-oil was worth about £32 per ton and tallow about £56 can readily be imagined, and although some years elapsed before the trade fully recognised its importance, it was eventually adopted by all soap-makers in every part of the Kingdom. The process is conducted as follows:—

Bleaching Palm-oil: Watt's Chrome Process.—One ton of raw palm-oil melted by steam heat and allowed to settle is placed in a wooden tub or vat, and is stirred with a wooden crutch until it has a temperature of about 120° F. or even lower in hot weather; 28 lbs. of bichromate of potassa are then dissolved in boiling water and the solution poured into the vat and the stirring continued; 60 lbs. of hydrochloric acid are then added, and the stirring vigourously kept up. In a few moments the oil assumes a dark brown colour, which in a few minutes changes first to a dark green and then quickly to a lighter green, with slight foaming, when the operation is complete. If small samples are taken from time to time and placed upon a piece of glass or porcelain, the rapid changes of colour appear very remarkable, and when the last stage is reached (which is sometimes the case within five minutes after the acid has been introduced) the oil upon the palette will be *perfectly* free from colour. If now a drop or two of the bleached oil be treated with a drop of soda ley, the mixture will be *quite colourless* if the operation has been properly conducted. A current of steam or a few pails of boiling water are now introduced, with brisk stirring, after which the oil is allowed to repose. In about twelve hours the "green liquor," as it is called, is drawn off by a plugged opening at the bottom of the vessel, and the bleached oil is then ready for the soap-copper. The green liquor, which contains oxide of chromium in solution, is carefully preserved, and may be treated *for the recovery of the chrome* by a process which will be described hereafter.

Instead of using hydrochloric acid, 40 lbs. of sulphuric acid and 60 lbs. of common salt may be used. The sulphuric acid is diluted with about twice its bulk of water, and the salt, previously dissolved in cold water, is mixed with the solution of bichromate of potassa in the proportion given. Some persons, in bleaching palm-oil by the above process, have been known to use as much as 40 lbs. of bichromate to the ton, an excess not only extravagant but unnecessary.

In bleaching palm-oil by the above process it is of great importance that the temperature of the oil should not be above 120° F., since the chemical action which takes place after the introduction of the bichromate and acid greatly augments the temperature of the oil, and when this latter stands at a higher point than we have indicated the bleached oil is liable to assume a brown or "foxy" colour. The author has most successfully bleached palm-oil when it has been almost at the point of congealing.

Recovery of the Chrome.—Although the recovery of the most costly ingredient employed in the process of bleaching palm-oil with chromic acid is not now, owing to the greatly reduced price of bichromate of potassa, of such paramount importance as it was formerly, there will be little difficulty in showing that even now, where this salt is used extensively, or even in moderate quantities, it will *pay* to save it from the gutter. The process, which was originated by Mr. Charles Watt, jun., may be described as follows:—The "green liquor" resulting from the bleaching of palm-oil, and which is rich in oxide of chromium, is placed in a wooden vat or tub. A quantity of slaked lime is worked up with water into what is termed *milk of lime*, small quantities of which are added cautiously, with continual stirring, to the green liquor, until all the free sulphuric or hydrochloric acid is saturated. No excess must be added, otherwise the oxide of chromium will be precipitated. When the saturation of the acid is complete the vessel is allowed to rest for an hour or two, after which the liquid is transferred to another vessel, and milk of lime again added and well stirred in, until the supernatant liquor is *colourless.*

After a few hours' rest the clear liquor is run off and fresh water added, which, after a further repose, is again run off, this operation of *washing* being continued until the clear liquor is tasteless. After about twelve hours' repose, the whole of the liquor is run off, and the *deposit*, which is a mixture of oxide of chromium and lime, after being well drained, is spread over an iron plate, with a furnace fire beneath to the depth of about two inches. The fire being kindled, the paste is first allowed to dry, when the heat is gradually increased. When the plate acquires a cherry-red heat the *grey* mass will gradually assume a yellow colour nearest the plate, and the mass will break up into irregular cakes. When these have become roasted about half through they must be turned over one by one, and the roasting continued until the whole assumes the yellow tint of *chromate of lime*. It will generally be found that the lumps will fall into a coarse powder, in which case, in order to ensure uniformity and to prevent *over-heating* (which must be strictly avoided) the substance should be constantly turned over by means of a trowel or shovel, a long-handled trowel being a most convenient tool for the purpose. It is advisable in practice to shift from the centre of the plate those portions which are sufficiently roasted* and to replace them with those which are less done; the finished material may be shovelled into an iron box or barrow, and there allowed to remain until cold, when it may be put into a cask until required for use.

Bleaching Palm-oil with Chromate of Lime.—About 60 lbs. of the chromate of lime prepared as above are sprinkled into a vat containing a ton of melted palm-oil, and well crutched or stirred in; and when the whole has been introduced 60 lbs. of hydrochloric acid are added, and the stirring continued until the usual reaction takes place and the oil is completely bleached. A few buckets of hot water may now be introduced with brisk agitation, and the usual time then allowed for settling. It is hardly necessary to say that the green liquor resulting from this opera-

* It is very important that the heat should be only of a dull red. Beyond this point the product becomes decomposed and useless.

tion may be treated as before, and the chrome again recovered.

Purifying Oils.—*Fish oils* may be purified by first boiling them with a weak caustic soda ley—about half a pound of the alkali dissolved in half a gallon of warm water to each ton of oil. This being well stirred into the oil, half a pound of sulphuric acid diluted with six times its weight of water is then added, the whole being boiled by steam for about a quarter of an hour. After about an hour's rest the liquid is run off from the bottom of the vat, and the operation of bleaching commenced. 4 lbs. of bichromate of potassa dissolved in hot water is first introduced, and this is immediately followed by adding 2 lbs. of sulphuric acid diluted as before; and after steam has been blown through the oil for a short time 1 lb. of nitric acid diluted with 1 quart of water is introduced, and the boiling continued for half an hour longer. The oil is then to be well washed with boiling water, and then allowed to rest until all the liquid matters have subsided.

All fixed vegetable oils and also fats may be purified and decoloured by means of chromic acid, but the operation is more effective when a solution of bichromate of potassa and either dilute sulphuric acid or hydrochloric acid are mixed during the process, when the alkali, being attacked by the acid, sets the chromic acid free. Melted kitchen-stuff and other rank fatty matters may be greatly improved, both in smell and colour, by judicious treatment with small quantities of bichromate and any mineral acid, but in order to remove the traces of green oxide of chromium which are apt to remain in fatty matters containing a considerable amount of stearine, it is advisable to well wash the bleached fat by the free use of steam or by means of boiling water, and the vessel in which the operations have been conducted should be well covered with sacking so as to retain the heat as long as possible, and thus facilitate the subsidence of the *green liquor*.

In the purifying of fish and other oils chloride of lime, made into a thin creamy mass, has frequently been employed, with the addition of dilute sulphuric acid. About

1 per cent. of the chloride and 1½ per cent. of sulphuric acid diluted with twenty times its weight of water are about the right proportions. The oil is first gently heated, the chloride of lime is then added and well stirred in, after which the dilute acid is introduced, and the agitation kept up until a sample exhibits a satisfactory appearance. Steam is then blown in or hot water applied to thoroughly wash the oil, when it is allowed to rest for some hours. The clear oil is then run off into a proper receptacle.

Solutions of tan, or tannic acid, followed by chloride of lime and dilute sulphuric acid have also been used in purifying fish oils.

Dunn's Method.—Mr. Dunn purified these oils by heating them with steam to a temperature of from 180° to 200° F., and then forcing a stream of hot air through the oil, after which the oil was washed by steam or hot water and afterwards filtered. A strong solution of common salt, or a mixture of salt and sulphate of copper (both in solution), and the whole well agitated for some time, is another method of purifying fish oil which has been frequently adopted. The oil is afterwards filtered through fresh charcoal, or is allowed to clarify by resting for a few hours.

Palm and other oils frequently contain foreign matter, the presence of which is likely to retard the chemical action of the bleaching agent; it is better, therefore, to remove these impurities by first heating the oil and then allowing it to rest for several hours, so that these matters may subside.

Justice's Method of Purifying and Bleaching Oils and Fats consists in mixing with these substances, while in a melted state, pulverised dry fuller's-earth, and then separating the earth from the oil or fat by allowing it to subside. The fatty matter to be purified is placed in any vessel suited to the purpose, and is heated until it is perfectly liquid. The temperature required of course varies with the different kinds of oil or fat, but it is simply sufficient that the material to be treated be brought to the liquid state. When the fat is thoroughly melted a quantity

of finely-powdered fuller's-earth, or an equivalent of clay, is spread over its surface and mixed with it by agitation, after which the fuller's-earth is allowed to subside. The fullers'-earth being now at the bottom of the vessel, the oil or fat, freed from impurities and colouring matter, but in other respects unchanged, is ready for use. The residuum, consisting of fuller's-earth mixed with oil, after the clear portion has been drawn off, may be put into boiling water, which separates the oil or fat from the earth and permits it to rise to the top, where it can be recovered. The refuse may then be thrown away or utilised in any desired manner. The amount of fuller's-earth to be used varies with the different kinds of fats and oils, say from 1 to 15 per cent. by weight of the fat or oil to be treated. No stills or machinery are needed, the only apparatus required being an ordinary vessel of suitable capacity in which to warm the oil or fat, and if desired one or more settling tanks.

CHAPTER XXVII.

RECOVERY OF THE GLYCERINE FROM WASTE OR SPENT LEYS.

Young's Process.—Payne's Process.—Versmann's Process.—O'Farrell's Process.—Thomas and Fuller's Process.—Allan's Process.—Lawson and Sulman's Process.—Clolus's Method.—Benno, Jaffé, and Co.'s Method.

It had always been a source of regret that the enormous quantity of glycerine set free during the process of saponification should have been ruthlessly wasted, and that no practical effort should have been made to recover this valuable product from the exhausted leys. The high price of glycerine, however, naturally turned attention to the soap-maker's waste leys, which were known to contain large quantities of this important substance; and to save it from its usual fate—the gutter—certain ingenious persons have devised various methods for its extraction. Of the several patents which have been obtained for recovering glycerine from spent leys, the following abstracts will prove interesting, but as these patents are of recent date they cannot, of course, be worked without the consent of the respective patentees.

Mr. Benjamin Young's Process consists in first putting the waste ley into capacious evaporating-pans or other suitable vessels, provided with coils of pipe made of any suitable metal, through which superheated or ordinary steam is passed. The free and carbonated alkalies (soda or potassa) are next neutralised by adding a solution of sulphuric acid in about the following proportions, namely, one part of water and one part of the sulphuric acid of commerce (68° B.), in about the proportion of two gallons of the diluted sulphuric acid to every forty gallons of the

waste soap-liquor. The solution of sulphuric acid is added to the waste soap-liquor in its original bulk, or when it is reduced to about one half that bulk by evaporation. Superheated or ordinary steam is then passed through the coils of pipe connecting with the evaporating-pans, and the waste liquor is concentrated to about one-tenth of the original volume. If any resin or fat is contained in the waste liquor it is admissible to add a slight excess of the dilute acid, and to remove the same—the resin or fat—by straining the concentrated liquor through cloth or any other suitable material made into bags or otherwise, after it has been evaporated to about one-tenth of its original volume. A small quantity of carbonate of lime is then added to the strained liquor, and it is further concentrated by evaporation until upon cooling it assumes the consistency of a syrup or paste, which consists of a mixture of chlorides and sulphates of soda and potassa, sulphate and carbonate of lime, and glycerine. The entire contents of the evaporating vessels are then placed in a centrifugal machine, such as is used for causing the separation of sugar from molasses, which is then set in motion and caused to rotate rapidly on its axis, thereby causing the removal of the glycerine. By this means the greater portion of the salts of soda, potassa, and lime are retained in the interior of the centrifugal machine, the glycerine being thrown off by the rapid rotation of the machine. As the glycerine thus obtained holds a certain quantity of salts in solution, these are separated by distillation.

Mr. George Payne's Process.—The inventor takes the spent ley resulting from the manufacture of soap and saturates any free alkali present with an acid. He prefers to use sulphuric, hydrochloric, or nitric acid. He then takes a solution of tannin or tannic acid, and adds this to the spent ley after being neutralised by the acid. This solution should contain about one part by weight of tannin or tannic acid to about ten parts by weight of water. The addition of the solution to the ley is continued until it ceases to precipitate any albuminous or gelatinous matter.

The precipitate which is thus formed is separated by filtration, or is allowed to settle. The remaining liquid consists chiefly of raw or impure glycerine and chloride of sodium. The solution should be warmed, as experience shows that heat facilitates the formation and separation of the precipitate. In some instances the solution may be found to be slightly acid; if so, it must be neutralised by the addition of milk of lime. The clear liquor, which is a mixture of glycerine and spent ley, is next heated to expel the water, thereby concentrating the mixture and removing from the same a large quantity of the salts, which will crystallise out during the process of evaporation. For this purpose heated air, superheated steam, or the direct heat of the fire may be employed.

By this process a concentrated solution of glycerine is obtained containing about 10 per cent. of salt, and the glycerine may be separated by distillation and refined in the usual way. The inventor says that "the glycerine obtained by this process may be more easily refined by distillation than that obtained by any known process."

Versmann's Process.—The object of this invention is the recovery of glycerine from soap leys, and its more or less complete separation from chloride of sodium, carbonate of soda, and caustic soda. A large percentage of these salts is separated by simply boiling down the soap ley and raking out the salts as they become insoluble. The concentrated solution is then allowed to cool, after which carbonic acid gas is passed through it until the whole of the carbonate and caustic soda is converted into bicarbonate of soda, which being much less soluble in glycerine than either the carbonate of soda or caustic soda, may readily be removed by filtration or other convenient means.

The inventor sometimes commences by passing carbonic acid gas through the original soap ley, but he finds it more convenient to first reduce the bulk of the liquid by boiling down, thereby separating large quantities of the salts, and then treating the liquid with carbonic acid. The liquid from which the bicarbonate of soda has been

removed is very rich in glycerine, but it still retains sensible quantities of chloride of sodium and other salts, the presence of which may act injuriously in the subsequent applications of the glycerine to certain purposes. These salts are separated by submitting the liquor, either hot or cold, to the process of "Osmose," in an apparatus known as the "Osmogene," such as is used in the separation of saline compounds from solutions of beet-root sugar. By this process nearly all the salts are separated from the glycerine. But as the latter becomes diluted with water it may be concentrated by evaporation, when it will be ready for the market as crude glycerine.

O'Farrell's Process.—The spent leys are evaporated immediately they are drawn off from the soap-pan by fire heat or dry steam applied by any suitable apparatus, till a saturated aqueous solution of common salt is obtained, and this saturated solution is used for the purpose of separating the glycerine from a fresh portion or second charge of soap, when the spent ley obtained from this fresh portion or second charge is evaporated, and this is again returned to the soap-copper for the purpose of separating the glycerine from a third charge, and the ley obtained is evaporated as before. The process is repeated until the quantity of glycerine present in the solution is sufficiently concentrated to be economically separated.

Having by this means obtained the maximum amount of glycerine in the minimum volume of spent soap leys, the inventor proceeds to evaporate the solution till as much salt as possible crystallises out, when the glycerine is dissolved out from the residue by means of methylated spirit or other suitable liquid, or the glycerine may be separated by distillation *in vacuo.*

Thomas and Fuller's Process.—The spent or partially spent leys are first evaporated until nearly all the salts are deposited; the resulting liquor, which is strongly impregnated with glycerine, is then boiled with an excess of fat or fatty acids, which readily combines with the soda salts, and removes all salts which may be in suspension in the liquor. The solution is then filtered and sub-

jected to distillation to recover the glycerine. Or the spent leys may be treated with quick-lime to convert the carbonate of soda into caustic soda, and after filtration boiled to concentration, and then fat or fat acid may be added to remove the soda and such salts as may be in suspension. The method described above, however, is preferred, using simply concentrated leys and a fat acid as the more effectual means of clearing the liquor of salts.

Allan's Process.—The inventor first neutralises the spent leys with any mineral acid with agitation. After settling, he adds a solution of alum, chloride of lime, or crude pyroligneous acid, stirring thoroughly. If preferred, he evaporates to nearly "salting point" before adding any of the substances mentioned above, and allows the precipitate to deposit. After settling he draws off the clear liquor and evaporates it to a concentrated condition in pans (to which the heat is only applied at the sides), or in shallow pans with sloping bottoms, to which the heat is applied. The liquor is then distilled in a glycerine retort heated by superheated steam from within, and provided with an exit pipe at the bottom, which carries off the precipitated salt as it accumulates.

Lawson and Sulman's Process consists in first evaporating the leys to a density of from 1·14 to 1·16, and allowing the solution to cool. The salt liquor being thus concentrated, the residual soapy matters remaining in solution are rendered insoluble, and, rising to the surface, may readily be removed by skimming or otherwise for further use. To remove the albuminous matters remaining in the liquor it is first heated, after which a salt of chromium sesquioxide is added, which is capable of tanning or rendering albumen insoluble. The quantity of the chromium salt added will depend upon the percentage of albuminous matter existing in the ley. The albuminous matters thus rendered insoluble by the addition of the salt are precipitated and removed.

The removal of these matters at this stage prevents their decomposition by further evaporation, and thus a

purer and more concentrated glycerine of better colour than usual is obtained. The alkalinity of the liquor is at the same time neutralised by a suitable acid.

The inventors remark, "A very convenient method of effecting our invention, so as to obtain these two results, *i.e.* the tanning of the albuminous matters and the neutralisation of the alkalinity, is to use the waste liquor resulting from the bleaching of tallow or other fats or oils (chrome liquor ?). For a ley such as the above we may add the bleaching liquor in the proportion of, say, 1 to 3 gallons for every 100 gallons of original ley; but this must depend entirely on the strength and colour of the ley. When treating highly-coloured leys, we add a proportion of free chromic acid to the waste liquor, which, by the oxidation and destruction of the colouring matters, is reduced to a salt of chromium sesquioxide capable of removing the albuminous matters as above."

The quantity of chromic acid will necessarily vary, but for the above quantity of ley we should say about half a pound of bichromate of potash added to a mixture of three-quarters of a pound of sulphuric acid in 2 lbs. of water, and add this mixture in the proportion of 5 lbs. to 20 lbs. to every 100 gallons of ley, according to circumstances. We now treat the liquor with a small excess of calcium carbonate (say, for example, 1 to 2 gallons "cream of whiting" to 100 gallons of ley), and maintain at a boiling temperature for a short time. This precipitates the whole of the chromic salts, and neutralises any slight proportion of acid remaining. The chromic oxide contained in the resulting precipitate can be recovered for another operation in any suitable and well-known manner. The resultant liquor obtained by removing the precipitate by subsidence or filtration will be found clear and almost colourless. It is then concentrated by further evaporation, which causes the gradual separation of the salt, which can be again used in the manufacture of soap.

The crude glycerine finally obtained is of greater purity and better colour than usual.

M. Victor Clolus's Method.—To effect a separation of

the various bodies for commercial purposes, and especially to extract the glycerine from spent leys, the inventor first saturates the ley, when cold, with hydrochloric acid. The solids are precipitated and collected; the neutral clear liquid is evaporated in any suitable heating apparatus. By degrees, as the evaporation proceeds, the salt is precipitated and is removed, subjected to the action of a turbine, and washed. In most cases this salt is sea-salt in a nearly pure state. The evaporation is arrested when the liquid has arrived at a density of about 32° B. At this point the glycerine contained in the ley still contains considerable quantities of salt in solution, the greater part of which is eliminated by the following treatment; that is to say, the glycerine liquid, at about 32° B., is poured into any suitable vessel and hot air is blown into it, or the liquid is otherwise heated and cold air blown into it. The air so heated, or heated by the glycerine itself, gradually eliminates the last traces of water in the glycerine, and salt is constantly precipitated, as the latter is very slightly soluble in anhydrous glycerine. To eliminate the water evaporation *in vacuo* might also be effected, but would be more expensive. As the final result, highly concentrated glycerine mixed with salt crystals is obtained. A turbine is used for eliminating the salt, which is systematically washed, and the water used for the washing is again treated.

The glycerine, thus purified by one or the other of these two processes, contains only a very small quantity of sea-salt in solution, and may be distilled. The inventor also adopts another method when he desires to obtain the carbonated or caustic salts of soda in the condition of carbonates, instead of transforming them into chlorides by means of hydrochloric acid. For this purpose he evaporates the ley and introduces into it carbonic acid, so as to convert the caustic soda into carbonate. When the liquor indicates about 25°, he allows the ley to cool, when he introduces an excess of carbonic acid, whereby bicarbonate of soda is formed, which is only slightly soluble, especially in a glycerine solution of salt. The greater

part is precipitated and is eliminated by means of a turbine. The bicarbonate is transformed into carbonate by calcination. The glycerine liquid which leaves the turbine is treated as before. If it is desired to obtain glycerine more free from salt, the operation is performed as follows:—The glycerine concentrated by air blown into it, or *in vacuo*, is treated with hydrochloric acid added in excess, either in a gaseous state or as a liquid. Sea-salt, being almost insoluble in an excess of hydrochloric acid, will be precipitated in fine crystals, and is eliminated by means of a turbine. The excess of hydrochloric acid then contained in the glycerine is eliminated either by blowing air into the same or by an excess of oxide of lead.

Benno, Jaffé, and Co.'s Method.—According to this process the inventors do not use common salt for separating the soap from the ley, but employ in lieu thereof an alkaline sulphate. The alkaline sulphates, especially the sulphate of soda, act upon the soapy liquor in the same manner as common salt, but there will be no difficulty in subsequently separating such sulphate from the glycerine. The spent ley obtained in eliminating the soap by means of sulphate of sodium has an alkaline reaction, and is, therefore, first neutralised by the addition of hydric-sodic sulphate; it is then filtered and ultimately evaporated. In the process of neutralising the spent ley the hydric-sodic sulphate is transformed into sulphate of soda by the caustic soda contained in the spent ley. When the liquid is evaporated the sulphate of soda separates in crystals, and is thus recovered as a bye-product. The sulphate of soda, which has been introduced for the purpose of separating the soap from the ley, is also separated, and if properly purified can be used again for eliminating soap from the ley. The liquid remaining after the crystallisation is glycerine containing a slight proportion of impurities, and can be further purified in the usual manner, as for instance by distillation.

CHAPTER XXVIII.

USEFUL NOTES AND TABLES.

Pickling Soap.—Under this attractive heading we may state that some *very* competitive soap-makers have occasionally adopted a plan of artificially hardening the surface of soap containing an infinitesimal proportion of fatty matter by soaking it for a few hours in a strong solution of common salt. The soap bars (which require careful handling!) are gently deposited in the strong brine, where they are allowed to remain until the surface is sufficiently indurated, after which they are quickly rinsed and then submitted to the drying-room for a short time. By this method the soap assumes a virtue which it does not possess.

The Oleometer.—This very useful instrument, for ascertaining the density of fixed oils, is thus described by Mr. Cooley:—"A delicate areometer or hydrometer, so weighted and graduated as to adapt itself to the densities of the leading fixed oils. As the differences of the specific

gravities of these substances are inconsiderable, to render it more susceptible the ball of the instrument is proportionately large and the tube or stem very narrow. The scale of the oleometer in general use (Gobby's) is divided into 50 degrees, and it floats at 0 or zero in *pure* poppy oil; at 38 or 38½ in *pure* almond oil, and at 50 in *pure* olive-oil. The standard temperature of the instruments made in this country is now 60°; those made on the Continent 54·5° F. The oil must therefore be brought to this normal temperature before testing it, by plunging the glass cylinder containing it into either hot or cold water, as the case may be; or a correction of the observed density must be made. The last is done by *deducting* 2 from the indication of the instrument for *each degree* of the thermometer *above* the normal temperature of the instrument, and adding 2 for every degree below it. Thus: suppose the temperature of the oil at the time of the experiment is 60° F. and the oleometer indicates 60°, then—

60·0° *Actual temperature.*
54·5 *Normal temperature.*

5·5 Difference.

Indication of the oleometer .... 61·0
The difference 5·5 × 2 =............ 11·0

Real density .... 50·0

Suppose the temperature observed at the time of the experiment is 52° and the oleometer indicates 45°, then—

51·5 *Normal Temperature.*
52·0 *Actual Temperature.*

2·5 Difference.

Indication of the oleometer .... 45·0
The difference 2·5 × 2 = ... 5·0

Real density.......... 50·0

The oil is therefore presumed to be pure.

Aluminate of Soda.—It has been proposed to employ this salt as a substitute for caustic soda in the manufacture of soap. Aluminate of soda is prepared from *bauxite*, an aluminate of iron, and from *cryolite*, a double fluoride

of sodium and aluminum. Bauxite is calcined with soda ash, whereby an aluminate of soda is formed, and the oxide of iron is separated by lixiviation, the resulting liquors being evaporated until a dry commercial aluminate of soda is obtained, the composition of which is—soda, 43; alumina, 40; water and impurities from the soda ash employed, 9. Cryolite (powdered) is mixed with six equivalents of lime and boiled with water, when an insoluble fluoride of calcium is formed and the alumina becomes dissolved in the excess of caustic soda. If an excess of lime is used, the alumina will be precipitated, leaving caustic soda alone in solution. We understand that soap is made in the United States to a considerable extent from aluminate of soda.

For making soap from aluminate of soda, about equal parts of lard and tallow are preferred, and these should not be heated to a greater extent than is just necessary to liquefy them. The materials are not boiled in the usual way, but the combination is effected at the lowest temperature at which they can be intimately mixed.

To determine the Quantity of Resin in Soaps.—Mr. Sutherland recommends the following process, which is said to give very satisfactory results:—300 grains of soap cut into small pieces are introduced into a capsule and covered with concentrated hydrochloric acid, the contents are gently boiled till the soap is dissolved and entirely decomposed; 4 ounces of hot water are added, and the capsule is set aside to cool. When cold, the cake of fatty acids and resin is removed and washed several times with warm water. After cooling it is dried and gently remelted, and kept for a few minutes at 212° to evaporate all traces of water.

This cake containing the fatty acids and the resin is carefully weighed.

100 grains of the mixture are placed in a capsule and covered with strong nitric acid and the temperature raised to the boiling-point; a powerful reaction takes place with violent evolution of nitrous vapours. The heat is withdrawn till the violence of the action subsides, and is

again applied to maintain a gentle ebullition for a few minutes. Small portions of nitric acid are successively added till no further distinctly appreciable quantity of nitrous acid is given off. The fatty acids are now allowed to cool, and are removed from the acid solution strongly coloured by terebic acid. The cake is then washed by melting it in a further quantity of nitric acid. When cold it is dried and melted at a gentle heat till acid fumes cease to be given off. The resulting cake is the pure fatty acid freed from resin, the latter being indicated by the loss. It will be observed that a correction must be made to obtain the exact relative proportions between fat and resin originally put into the soap-pan, as fats on being decomposed lose about 4½ per cent. of their original weight. Hence, in making the calculation a proportionate addition must be made to the fatty acid before dividing its weight by that of the resin indicated. This process may be also used to determine resin in bees'-wax.

Detection of Resin in Soap.—Mr. C. Barford decomposes the soap with hydrochloric acid, and washes the mass thus obtained with water. He then treats it with a caustic soda ley of the specific gravity of 1·1 diluted with 6 volumes of water, avoiding excess. He then evaporates it to dryness over a water-bath, grinds up the residue, and dries in stove at 100°. One portion of this powder is utilised for the determination of the fatty acids, and another portion is put into a very dry bottle, and from 5 to 6 per cent. of absolute alcohol are added for every gramme of soap. It is heated at 80°, to dissolve the soap of the fatty acids and of resin, and allowed to cool again while well stoppered. The alcoholic liquid, when cold, is mixed with 5 times its volume of ether. The whole is well shaken up and left to settle. The resin soap is entirely dissolved, whilst the soap of the fatty acids is deposited almost entirely. After standing for 24 to 48 hours the ethereal liquid is decanted, and the residue is treated with hydrochloric acid. This method is based upon the slight solubility of a soda soap of the fatty acids in the above mixture of alcohol and ether.

Cheap Almond Soap.—To impart the odour of bitter almonds to soap, *nitro-benzol* has been much employed. It is exceedingly powerful as a perfume, and must therefore be used in moderation. It is largely used in some parts of England for scenting cheap tablet soaps. In small quantities it has also been employed to disguise the disagreeable odour of cocoa-nut oil.

Analyses of Soft Soaps.—The following analyses may be useful as showing the composition of several well-made soft soaps:—

Good soft soap of London make: Potash 8·5 + oil and tallow 45 + water 46·5 in 100 parts.—*Ure.*

Thenard gives the composition of soft soap as: Potash 9·5; oil 44·0; water 46·5 = 100.

Belgian soft or green soap: Potash 7 + oil 36 + water 57 = 100.—*Ure.*

Scotch soft soap: Potash 8 + oil and tallow 47 + water 45 = 100.—*Ure.*

Another well-made soap: Potash 9 + oil and fat 34 + water 57 = 100.

An olive-oil (Gallipoli) soft soap from Scotland consisted of potash with a good deal of carbonic acid 10, oils 48, water 42 = 100.—*Ure.*

A rapeseed oil from Scotland consisted of potash 10 + oil 51·66 + water 38·33.

A semi-hard soap from Verviers, for fulling cloth, called *savon économique*, consisted of potash 11·5 + fat (solid) 62 + water 26·5 = 100.—*Ure.*

M. Juncmann proposes to make a soap by dissolving 28 parts of soda ash in 100 parts of molasses, and stirring in 100 parts of oleic acid.

Potato Flour in Soft Soap.—In the year 1838 Sheridan (the original inventor of silicated soap) obtained a patent for making soft soap with potato flour. The proportions were: potato flour, 16 lbs.; potash leys, 100 lbs.; water, 270 lbs. How many times has the same process been, with slight modifications, re-patented!

Liquored soaps are such as have water (with or without silicate of soda) added to them after removal from

the pan. *Watered*, or "run" soaps are those which have water or weak leys added and mixed with the soap *in* the soap-pan.

Saponification of Neutral Fatty Bodies by Soaps. By M. J. Pelouze.—One of the oldest and most skilful candle-makers in France, M. de Milly, made a series of important experiments on the saponification of fatty matters, and especially suet, by lime, in which he demonstrated that a much smaller percentage of lime than was ordinarily employed would effect the complete saponification of the fatty matter. Having reduced the percentage of lime from 15 to 8 or 9 per cent., he subsequently reduced the proportion to 4 per cent. of the fatty matter operated upon, the condition being that of subjecting the lime, water, and fatty matter to an elevated temperature. The operation was performed in a metallic boiler, which was maintained for several hours at a temperature corresponding to a pressure of 5 to 6 atmospheres.

It is easy to understand the economy of an operation which enables us to diminish to one half the quantity of sulphuric acid necessary for the decomposition of the lime soap. It appeared to me interesting to subject to an attentive examination a saponification performed with so small a quantity of a base as one twenty-fourth part of the acidified fatty matter.

I prepared a lime soap by double decomposition, by pouring a solution of chloride of calcium into an aqueous solution of commercial soap. The precipitate, when well washed, was introduced into a small Papin's digester, with nearly its own weight of water and 40 per cent. of olive oil. The vessel was kept for nearly three hours in an oil bath at a temperature of from 311° to 329° F. The water above the precipitate was evaporated, and left a syrupy residue presenting all the properties of glycerine.

The precipitate, when boiled in water acidulated with hydrochloric acid, furnished a completely acidified fatty matter; for it was directly and entirely soluble in alcohol and the alkalies. In one word, the reaction showed all the characters of the ordinary decomposition of the neu-

tral fatty matters by the free alkalies. The difference in hardness of the new lime soap being set aside (it was not so hard), one might have supposed that the saponification had been performed with caustic lime.

Another experiment was made by mixing Marseilles soap with its weight of water and one quarter of its weight of olive-oil. The temperature and operation were the same. The matter, after the reaction, had all the properties of an acid soap: it was soluble in cold alcohol and in an aqueous solution of potassa or soda. Acids separated from it a fatty substance likewise entirely soluble in cold alcohol and alkaline solutions.

It results from the double experiment, which has just been described, that soaps are as capable as alkalies of decomposing fatty bodies into glycerine and fatty acids; it will thus be understood why I have given to this note the apparently paradoxical title, *Saponification of Neutral Fatty Matters by Soaps.*

I have, moreover, ascertained that at the temperature of 329° F. water does not act on oils. To decompose them it is necessary that the mixture of fatty matters and water should attain and be maintained for a long time at the temperature of 428° F. assigned by M. Berthelot for this latter saponification.

In England, where Price's house manufactures immense quantities of stearine candles, the saponification is performed by the action of superheated steam at a still higher temperature. Thence result fatty acids and free glycerine which is nearly pure, and whence arts, manufactures, and medicine have already drawn great advantages, and which will, probably, be much increased.

In the new reactions of which we speak it will be understood that water, at a temperature of from 311° and 329° F., decomposes a neutral soap into an acid soap and very basic soap, and that the latter acts in a secondary manner on a fresh quantity of fatty matter in the same manner that a free alkali would do. The observations of M. Chevreul, relative to the action of water on soaps, accord with this explanation.

The experiment of M. Milly, which served as a foundation for my work, may be explained in an analogous manner.

It must be admitted that the saponification of suet by means of 4 per cent. of its weight of lime presents several distinct phases in which a basic or neutral soap is formed at first and is then changed into a relatively acid soap.

The observations of which I have been giving a summary find a simple interpretation in M. Chevreul's works on fatty bodies. They lead us to look forward to fresh developments in this class of numerous and important substances. When the elements of water alone cause the decomposition of neutral fatty bodies into fatty acids and glycerine, we may expect that science and industry will multiply and vary the phenomena of saponification.

Jellifying is a term applied to soap which, after being dissolved in a certain quantity of water, sets into a jelly when cold. Soap-makers frequently test the jellifying property of their soaps in this way:—After having carefully weighed 1 ounce of soap, this is cut up into thin shavings, and these are placed in a porcelain capsule; 7½ ounces of water (by measure) are then added, and the whole gently boiled over a spirit-lamp, constantly stirring with a glass rod until the soap is all dissolved. Cold water is then added to make up 16 ounces, and the solution of soap is then set aside to cool. If the soap is of good quality it should gelatinise in half an hour. In cloth factories, and large laundries also, the character of soap is determined by its congealing or jellifying properties. For this purpose 1 cwt. of soap is boiled by steam heat in 80 gallons of water. When thoroughly dissolved, cold water is added to make up 170 gallons in all. At the end of twelve hours or so the solution of soap will have set into a jelly if the soap has been of good quality.

Twaddell's hydrometer is used in England for liquids heavier than water. Its degrees are converted into specific gravities by multiplying them by 5, adding 1,000, and dividing the sum by 1,000. Thus:—

$$20 \text{ Tw.} = \frac{20 \times 5 \cdot + 1000}{1000} = 1{\cdot}100$$

Twaddell's figures advance 5° in each number, thus:—

1000 specific gravity	is No.	0
1005 ”	”	1
1010 ”	”	2
1015 ”	”	3
1020 ”	”	4

and so on.

Causticising Soda.—Mr. Parnell's plan for causticising soda liquor under pressure appears to have proved very successful in practice and to have effected a considerable saving in fuel. The operation is conducted in horizontal cylinders about 7 feet in diameter and 30 feet long, provided with a revolving shaft or agitator and "cages" for holding the lime. Each charge is about 400 cubic feet of soda liquor, and takes about three and a half to four hours to causticise under a pressure of from 50 to 60 lbs. to the square inch. It is stated that 90 or 92 per cent. of the soda is causticised by this method, and the caustic liquor comes out up to 32° Twaddell. The "mud" contains from 3 to 4 per cent. of free lime. Each ton of 70 per cent. caustic soda requires 15 or 16 per cent. of lime. One apparatus turns out about 70 tons weekly. The patentee says:—"1. I treat the alkaline carbonates, or alkaline carbonates mixed with caustic lime, under a pressure greater than the ordinary atmospheric pressure, so as to obtain a sufficiently high temperature to cause the alkaline carbonate and the caustic lime to react upon each other. Thus it is possible, under pressure of 50 lbs. per square inch, to effect the reaction with a solution of 1·200 specific gravity or over. 2. I agitate the mixed alkaline carbonates and lime during treatment in the manner above described in order to facilitate the reaction and hasten its completion. 3. After the reaction has taken place I maintain the pressure upon the products, and keep the temperature constant until I have separated the caustic soda or potassa, or both, from the carbonate of lime produced, in order that the reaction may not be reversed by a reduction of temperature taking place whilst the caustic alkalies and the carbonate of lime are in contact.

Soda Soft Soap may be made from a mixture of soda

and potash leys, but the leys must be quite free from salt. The proportions recommended are: Soda ley, 1 part; potash ley, 4 parts; oleic acid, 100 lbs.; tallow, 50 lbs.; hempseed-oil, 3,750 lbs. This is said to make a good soft soap.

Half-palm Soap may be made from either of the following formulæ:—

1.	
White tallow	900 lbs.
Palm-oil	400 ,,
Cocoa-nut oil	200 ,,
Yellow resin	100 ,,
	1600

2.	
Tallow	700 ,,
Palm-oil	300 ,,
Cocoa-nut oil	200 ,,
Cotton-seed oil	400 ,,
	1600

3.	
Lard	550 lbs.
Tallow	400 ,,
Cotton-seed oil	450 ,,
Resin	200 ,,
	1600

The following formulæ, recommended by Ott*, may prove useful:—

Palm-oil	300 lbs.
Tallow	200 ,,
Resin	20 ,,
	520

Tallow	500 ,,
Palm-oil	300 ,,
Resin	200 ,,
	1000

Palm-oil	450 lbs.
Cocoa-nut oil	50 ,,
	500

Lard	550 ,,
Palm-oil	150 ,,
Cocoa-nut oil	50 ,,
Clarified resin	50 ,,
	800

Adulteration of Commercial Silicate of Soda.—The sample in question gave on analysis, according to M. F. Jean—

Soda combined with silica	8·54
Carbonate of soda	6·36
Soda soap	2·00
Silica	21·40
Ferric oxide, alumina, and traces of lime	0·74
Alkaline chloride and sulphates	0·66
Water	60·05
Matter not determined, and loss	0·25

The sample of silicate of soda contained, therefore, 2 per cent. of anhydrous soap, but as such a solution

* "Art of Manufacturing Soap," &c. By Adolphe Ott.

forms a jelly on cooling, the object of its introduction was evidently to thicken the silicate, giving it the appearance of a very concentrated product, and to prevent its strength being taken with the hydrometer.

Soaps for Calico-printers.—The soap used by calico-printers for clearing alizarine work must be very neutral, the alkali being not only kept down in quantity, but its thorough combination with the fatty acids secured by very careful boiling. The superiority of the madder purples for which the firm of Hoyle and Sons were long famous was due to their practice of re-melting the best soaps procurable with an additional quantity of palm-oil.

Fulling Soaps.—For use in woollen manufacture a genuine potash oil-soap has been found in practice superior to all others. Resin gives harshness to the fibre of wool, so must not therefore on any account be used. Soda also injures the suppleness of the wool, so in discarding it the manufacturer follows the teachings of Nature. The natural lubricant of wool, called *suint*, is a kind of potash soap, containing a bare trace of soda. Silicates also must not be used; if present they are decomposed in the process of fulling, &c., and deposit free silica, which grates on the fibre and injures its lustre.

To prevent the boiling-over of the Copper, a piece of machinery called a "fan" is used at some soap-works. This consists of a revolving paddle furnished with blades which touch the top of the boiling matter.

Small jacket-pans may be made from the alloy of aluminium and bismuth of the Crown Aluminium Company, instead of silver, which possesses the advantage of being cheaper, harder, and less fusible than the more costly metal.

Palm-kernel Oil.—The Diamond Oil Company of Liverpool recently favoured the author with a sample of this oil, which would appear to be a useful material in soap-making, judging from its firmness at the temperature of 70°. It bears a strong resemblance to cocoa-nut oil.

Cotton-seed and Palm-nut Oils.—On account of the high price of tallow, these oils are almost indispensable to

the soap manufacturer. Both oils are commonly used together for making hard soaps, cotton-seed oil being particularly useful in summer, on account of the large proportion of stearine (about 30 per cent.) it contains, which renders the soap more compact and capable of withstanding the action of higher temperatures. Crude cotton-seed oil has a reddish-brown colour, and when intended for exportation is usually treated with soda. The oil thus refined has a density of 0·926, and solidifies at about 2½ C. During late years cotton-seed oil has been extensively used for the adulteration of olive-oil. Palm-nut oil is obtained from the palm-nut, either by pressure or extraction with carbon disulphide* or light petroleum, the latter being preferable, as carbon disulphide, when not perfectly eliminated from the oil, causes serious trouble, giving both a bad smell and colour to the soap made from it. Palm-nut oil is seldom used by itself for soap-making, as it produces a very brittle and easily cracked soap, which combines with but little water, and thus causes the produce to be very low. Palm-nut oil is, however, of importance when mixed with other fats. In order to free ordinary refined cotton-seed oil from colouring matter, it is treated with the entire quantity of ley, at 24° Baumé, required for the complete saponification of the fats to be used, and the mixture is boiled. The other fats are now added, and after addition of water the saponification, which has not yet entirely taken place, is completed.—*Journal of the Society of Chemical Industries.*

Specific Gravity of Lard, &c.—According to De Saussure, the specific gravity of hogs' lard at 60° is 0·938 (water 1,000); in its fluid state, at 122°, it is 0·892; at 155° it is 0·881, and at 200° it is 0·863. The specific gravity of—

	at 53°	at 75°	at 122°	at 200°
Nut-oil is	0·928	0·919	....	0·871
Almond oil	0·920	....	....	0·863
Linseed "	0·939	0·930	0·921	0 881
Castor "	0·970	0·957	....	0 908
Olive "	0·919	0·911	0·893	0·862

* Bisulphide of Carbon.

DALTON'S TABLE SHOWING THE PROPORTION OF DRY SODA IN LEYS OF DIFFERENT DENSITIES.

Specific gravity of solution	Dry soda per cent. by weight.	Boiling point.	Specific gravity of solution.	Dry soda per cent. by weight.	Boiling point.
1·85	63·6	600°	1·36	26·0	235°
1·72	53·8	400°	1·32	23·0	228°
1·63	46·6	300°	1·29	19·0	224°
1·56	41·2	280°	1·23	16·0	230°
1·50	36·8	265°	1·18	13·0	217°
1·47	34·0	255°	1·12	9 0	214°
1·44	31·0	248°	1·06	4·7	213°
1·40	29·0	242°			

DALTON'S TABLE SHOWING THE PROPORTION OF DRY POTASH IN LEYS OF DIFFERENT DENSITIES.

Specific gravity.	Potash per cent.	Boiling point.	Specific gravity.	Potash per cent.	Boiling point.
1·68	51·2	329°	1·33	26·3	229°
1·60	46·7	290°	1·28	23·4	224°
1·52	42·9	276°	1·23	19·5	220°
1·47	39·6	265°	1·19	16·2	218°
1·44	36·8	255°	1·15	13·	215°
1·42	34·4	246°	1·11	9·5	214°
1·39	32·4	240°	1·06	4·7	213°
1·36	29·4	234°			

COMPARATIVE FRENCH AND ENGLISH THERMOMETER SCALES.

French, or Centigrade.		English, or Fahrenheit.
0 Cent. or C.	equals	32 Fahr. or F.
5 ,,	,,	41 ,,
10 ,,	,,	50 ,,
15 ,,	,,	59 ,,
20 ,,	,,	68 ,,
25 ,,	,,	77 ,,
30 ,,	,,	86 ,,
35 ,,	,,	95 ,,
40 ,,	,,	104 ,,
45 ,,	,,	113 ,,
50 ,,	,,	122 ,,
55 ,,	,,	131 ,,
60 ,,	,,	140 ,,
65 ,,	,,	149 ,,
70 ,,	,,	158 ,,
75 ,,	,,	167 ,,

COMPARATIVE FRENCH AND ENGLISH THERMOMETER SCALES—(*continued*).

French, or Centigrade.		English. or Fahrenheit.
80 Cent. or C.	equals	176 Fahr. or F.
85 „	„	185 „
90 „	„	194 „
95 „	„	203 „
100 „ (Water boils)	„	212 „ (Water boils).
200 „	„	392 „
300 „	„	572 „
356 „ (Mercury boils)	„	662 „ (Mercury boils).

TABLE SHOWING THE SPECIFIC GRAVITY CORRESPONDING WITH THE DEGREES OF BAUMÉ'S HYDROMETER.

Liquids denser than Water.

Degrees.	Specific Gravity.	Degrees.	Specific Gravity.	Degrees.	Specific Gravity.
0	1·0000	26	1·2063	52	1·5200
1	1·0066	27	1·2160	53	1·5353
2	1·0133	28	1·2258	54	1·5510
3	1·0201	29	1·2358	55	1·5671
4	1·0270	30	1·2459	56	1·5833
5	1·0340	31	1·2562	57	1·6000
6	1·0411	32	1·2667	58	1·6170
7	1·0483	33	1·2773	59	1·6344
8	1·0556	34	1·2881	60	1·6522
9	1·0630	35	1·2992	61	1·6705
10	1·0704	36	1·3103	62	1·6889
11	1·0780	37	1·3217	63	1·7079
12	1·0857	38	1·3333	64	1·7273
13	1·0935	39	1·3451	65	1·7471
14	1·1014	40	1·3571	66	1·7674
15	1·1095	41	1·3694	67	1·7882
16	1·1176	42	1·3818	68	1·8095
17	1·1259	43	1·3945	69	1·8313
18	1·1343	44	1·4074	70	1·8537
19	1·1428	45	1·4206	71	1·8765
20	1·1515	46	1·4339	72	1·9000
21	1·1603	47	1·4476	73	1·9241
22	1·1692	48	1·4615	74	1·9487
23	1·1783	49	1·4758	75	1·9740
24	1·1875	50	1·4902	76	2·0000
25	1·1968	51	1·4951		

TABLE SHOWING THE SPECIFIC GRAVITY CORRESPONDING WITH THE DEGREES OF BAUMÉ'S HYDROMETER.

Liquids lighter than Water.

Degrees.	Specific Gravity.	Degrees.	Specific Gravity.
10	1·0000	36	0·8488
11	0·9932	37	0·8439
12	0·9865	38	0·8391
13	0·9799	39	0·8343
14	0·9733	40	0·8295
15	0·9669	41	0·8249
16	0·9605	42	0·8202
17	0·9542	43	0·8156
18	0·9480	44	0·8111
19	0·9420	45	0·8066
20	0·9359	46	0·8022
21	0·9300	47	0·7978
22	0·9241	48	0·7935
23	0·9183	49	0·7892
24	0·9125	50	0·7849
25	0·9068	51	0·7807
26	0·9012	52	0·7766
27	0·8957	53	0·7725
28	0·8902	54	0·7684
29	0·8848	55	0·7643
30	0·8795	56	0·7604
31	0·8742	57	0·7656
32	0·8690	58	0·7526
33	0·8639	59	0·7487
34	0·8588	60	0·7449
35	0·8538	61	0·7411

TABLE OF ESSENTIAL OILS.

Name.	Colour.	Name.	Colour.
Oil of absinthe (wormwood)	green	Oil of mugwort .	yellow
" dill	yellow	" elecampane	white
" anise	"	" badiane	yellow
" ache, or parsley	"	" angelica	"
		" Portugal	"

TABLE OF ESSENTIAL OILS—(*continued*).

Name.	Colour.	Name.	Colour.
Oil of cinnamon	yellow	Oil of yarrow	blue and green
„ chamomile	blue	„ marjoram	yellow
„ cajeput	green	„ mustard	deep brown
„ cascarilla	yellow	„ nutmeg	yellow
„ caraway	„	„ neroli	orange
„ chervil	lemon yellow	„ pennyroyal	yellow
„ lemon	yellowish	„ rosemary	white
„ cochlearia	„	„ sage	green
„ coriander	white	„ saffron	yellow
„ cumin	yellow	„ sassafras	„
„ dittany	brown	„ turpentine	white
„ fennel	white	„ thyme	yellow or pale green
„ galangal	yellow	„ rose	white
„ genista	„	„ valerian	green
„ juniper	green	„ pimento	slightly yellow
„ ginger	yellow	„ rhodium	yellow
„ cloves	„	„ savin	limpid
„ hyssop	„	„ tansy	yellow
„ lavender	„	„ rue	yellow-green
„ cherry laurel	„	„ bergamot	yellow
„ crisp mint	white	„ serpolet (lemon thyme)	light brown
„ peppermint	„		
„ balm mint	„		
„ motherwort	blue		

FUSING AND CONGEALING POINTS OF FATS AND OILS.

Substance.	Degrees Fahrenheit
Castor and poppy oils freeze at	0 or Zero.
Walnut-oil freezes „	15°
Oil of beechnuts freezes „	29°
Almond-oil congeals „	30°
Olive-oil freezes „	36°
Horses' fat fuses „	55°
Cocoa-nut oil solidifies „	70°
Lard fuses „	74°·5
Oil of roses and oil of cedar-wood solidify at	79°
Lard melts at	97°
Spermaceti fuses „	107°
Palm-oil melts „	117½°
Margarine fuses „	120°
Tallow fuses „	127°
Bees'-wax fuses „	150°
Stearine melts „	158°
Resin becomes soft „	160°
Dammara resin fuses „	164°

KURTEN'S TABLE

SHOWING THE COMPOSITION AND PRODUCT OF SOAP BY THE COLD PROCESS FROM CONCENTRATED LEY AND MIXTURE OF COCOA-NUT OIL WITH PALM-OIL, LARD, AND TALLOW.

Soap.	Tallow.	Cocoa-nut Oil.	Palm Oil.	Lard.	Ley.	Degrees.	Salt Water.	Degrees.	Potash.	Degrees.	Product.
Cocoa-nut oil No. 1	”	100	”	”	56	36	”	”	”	”	153
Paris toilet, round	20	30	”	8	31	36	”	”	5	36	87
” ”	”	25	”	75	50·52	36	”	”	”	”	150
Windsor, square	66	34	”	”	77	30	”	”	13	30	185
	66	34	”	”	”	”	”	”	”	”	”
Shaving No. 1	or	or	”	”	120	27	”	”	”	”	214
	33	34	33	”	”	”	”	”	”	”	”
Shaving No. 2	33	34	33	”	120	27	12	12	”	”	224
	60	40	”	”	”	”	”	”	”	”	”
Washing No. 1	or	or	”	”	125	27	25	12	”	”	244
	30	40	30	”	”	”	”	”	”	”	”
	40	60	”	”	”	”	”	”	”	”	”
” No. 2		or	”	”	135	27	50	15	”	”	278
	”	100	”	”	”	”	”	”	”	”	”
	or	or	”	”	”	”	”	”	”	”	”
Ordinary cocoa-oil	10	90	”	”	225	21	75	12	”	”	400
		or	”	”	”	”	”	”	”	”	”
		90	10	”	”	”	”	”	”	”	”

BOILING POINTS OF SOME VOLATILE OILS.

Substance.	Degrees Fahrenheit.
Oil of sassafras begins to boil at	223
” tar (creosote) begins to boil at	280
” amber boils at	284
” hyssop ”	289·4
” grass ”	297
” garlic ”	302
” coriander ”	302
” elemi ”	345
” bitter almonds boils at	350
” thyme boils at	356
” orange-peel boils at	356

Boiling Points of Caustic Alkaline Leys.

Alkaline Ley.	Specific Gravity.	Percentage of Alkali.	Boils at Degrees Fahrenheit.
Soda	1·18	13	217
Potash....	1·23	19·5	220
Soda	1·23	16	220
Potash....	1·28	23·4	224
Soda	1·29	19	224
Soda	1·32	23	228
Potash....	1·33	26·3	229
Soda	1·36	26	235
Soda	1·40	29	242
Potash....	1·42	34·4	246
Soda	1·47	34	255
Potash....	1·44	36·8	255
Soda	1·5	36·8	265
Potash....	1·52	42·9	276
Potash....	1·6	46·7	290
Soda	1·63	46·6	300
Potash....	1·68	51·2	329

Table showing the Quantity of Caustic Soda in Leys of different Densities (Water 1000).

Specific Gravity.	Soda Per Cent.	Specific Gravity.	Soda Per Cent.
1·00	0·00	1·22	20·66
1·02	2·07	1·24	22·58
1·04	4·02	1·26	24·47
1·06	5·89	1·28	26·33
1·08	7·69	1·30	28·16
1·10	9·43	1·32	29·96
1·12	11·10	1·34	31·67
1·14	12·81	1·35	32·40
1·16	14·73	1·36	33·08
1·18	16·73	1·38	34·41
1·20	18·71		

TABLE OF THE MECHANICAL POWER OF STEAM.

Pressures.		Temperature in Degrees of Fahrenheit.	Pressures.		Temperature in Degrees of Fahrenheit.
Atmosphere.	Pounds per square inch.		Atmosphere.	Pounds per square inch.	
1·00	14 70	212·00	4·50	66·15	300·27
1·25	18·38	223·88	5·00	73·50	307·94
1·50	22·05	234·32	6·00	88·20	320·00
1·75	25·72	242·78	7·00	102·90	331·56
2·00	29·40	250·79	8·00	119·60	340·83
2·25	33·08	257·90	9·00	132·30	351·32
2·50	36·75	263·93	10·00	147·00	359·60
2·75	40·42	269·87	12·50	183·75	377·42
3·00	44·10	275·00	15·00	220·50	392·90
3·25	47·78	279·86	17·50	257·25	406·40
3·50	51·45	284·63	20·00	294·00	418·56
3·75	55·12	288·66	25·00	367·50	499·34
4·00	58·18	292·91	30·00	441·00	457·16

APPENDIX A.

Making Soap in small Quantities.—Pearl Soap-Powder.—Extract of Soap. —Washing-Powder.—Wool-washing Compound—Universal Washing-Powder.—The Recovery of Glycerine from Waste Leys.—Allen and Nickel's Method.—Venables' Process.—Modern German Method of Making Soap.—Removal of Free Alkali from Soaps.—Transparent Soaps made by Cold Process.—Mialhe's Neutral Soap.—Samphire Soap.—Dr. Wright's Classification of Soap Processes.—Marine Soap or Hydrated Soap.—Blake and Maxwell's Processes.—Testing Soaps. —Determination of Glycerine.—Dr. Muter's Method.—Determination of Resin in Soap.—Eichbaum's Soap.—Soaps for Calico Printers and Dyers.—Soap for Silk Dyers.—Soap Leaves.—Zalmon's Aromatic Mouth Soap.—Aromatic Antiseptic Tooth Soap.—Unna's Over-fatty Soaps.—Dimbleby's Wych-hazel Soap.—Castor Oil Soap.—Weise's Formula for Windsor Soap.—Rendering Tallow.—Silicates of Soda and Potash.—Way's Process.—Barring Soap by Machinery.—Way's Silicated Soap.—Blue and Grey Mottled Soaps.—Fulling Soap.—Soap to Remove Stains.—Cotton-seed Oil.—Chlorinated Soap.—Commercial Value of Soaps.

Making Soap in Small Quantities.—For some years past the Greenbank Alkali Company, of St. Helen's, Lancashire, have prepared and popularized a refined 98 per cent. caustic soda in a *fine powder*, packing it in cans holding from 10 lbs. to 4 cwt. The powdered soda does not deliquesce and liquefy like ordinary caustic soda, and any quantity may be taken from the can and the remainder not deteriorate even if the vessel be left open for some days. To make soap with this alkali no boiling pans are required, and it is perfectly easy to make a few pounds of soap at a time if the following directions are exactly followed :—

1. Take exactly 10 lbs. of double refined 98 per cent. caustic soda powder (Greenbank), put it into any can (not coated with tin) or jar with 4½ gallons of water, stir it once or twice, when the soda will quickly dissolve and become quite hot. Let it stand until the ley thus made is

cold. 2. Weigh out and place in any convenient vessel for mixing 75 lbs. of clean grease, tallow, or oil (*not* mineral oil). If grease or tallow be used, melt it slowly over a fire until it is liquid, and of a temperature not over 100° Fahr. If oil be used no heating is required. 3. Pour the ley *into* the melted fat or oil in a continuous stream, at the same time stirring with a flat wooden stirrer about 3 inches broad. Continue gentle stirring until the ley and fat are thoroughly combined and appear of the consistence of honey. Do not stir too long, or the mixture will separate again. The time required varies somewhat with the weather and the kind of tallow, grease, or oil used; from fifteen to twenty minutes is generally sufficient. 4. When the mixing is completed pour off the liquid soap into any sufficiently large square box for a mould, previously damping the sides with water so as to prevent the soap sticking. Wrap up the box well with old blankets or, better still, leave it in a warm place until the next day, when the box will contain a block of 130 lbs. of soap, which can afterwards be cut up with a wire (see page 127). If the grease or tallow be not clean, or contain *salt*, it must be *rendered*, or purified, by boiling with water so as to throw out impurities. The presence of salt would spoil the operation entirely (causing the ley to separate), but discoloured or rancid fat is quite admissible.

If the soap turn out streaky or uneven it has not been thoroughly mixed. If very sharp to the taste too much soda has been taken; if soft, mild, and greasy, too little. In either case it must be thrown into a pan and brought to a boil with a little more water. In the first case boiling is all that is necessary; in the others a little more oil or a little more soda must be added. Any smaller quantity of soap than the above may be made by taking the ingredients in smaller proportions, but it is not advisable to make more than double the quantity prescribed, as it would be difficult to work more by hand. By working successive batches, however, a person could turn out 2 tons of soap a day simply with apparatus obtainable in every household. By adding a few drops of an essential

oil when the mixing is complete, a toilet soap is produced. Oil of mirbane (artificial almond oil) is the cheapest, but the perfume is not nearly so pleasant as real almond oil, citronella, or oil of cloves.* When made with clean grease or tallow, or light-coloured oil, the soap produced is quite white.*

Pearl Soap Powder is prepared from curd soap (powdered) 4 parts, sal soda (crude carbonate of soda) 3 parts, silicate of soda 2 parts. The ingredients must be dried as much as possible and all intimately mixed.

Extract of Soap.—Soap 14·3 parts; anhydrous soda 30 parts, water 55 parts. Manufactured from soda crystals and soda soap.

Washing-Powder.—A powdery mixture composed of effloresced soda 90 parts, hyposulphite of soda 10 parts, and borax 2 parts.

Wool-Washing Compound.—This is a mixture composed of dried soda 35 parts, powdered soap 10 parts, and sal ammoniac 10 parts.

Universal Washing-Powder.—This powder consists of silicate of soda, with a small percentage of powdered soap and starch.

Recovery of Glycerine from Waste Leys.—Mr. Kingzett, in an important paper on this subject,† classes the various processes as designed to effect the following objects:—1. To remove, or destroy, albuminous or soapy matters, together with any residual soap in the spent leys. 2. To facilitate the removal of the salt, either by employing means to diminish the solubility of the chloride of sodium, in cases where that substance is used, or to substitute another which may be more readily and profitably removed. 3. To economise the cost of concentrating the leys to that point at which the glycerine may be at once employed for certain purposes in its then crude condition, or still further purified by distillation.

Allen and Nickel's Method.—"Lancashire leys," besides the impurities already noticed, contain sulphides, hypo-

* W. J. Menzies, in *Chemist and Druggist*, 1880, p. 339.
† *Journal of Society of Chemical Industry*, 1882, p. 78.

sulphites, cyanides, ferrocyanides, sulphocyanides, &c., owing to the custom, in that part of the north, of saponifying with causticised *black-ash* liquor instead of caustic soda. The impurities named render it very difficult to recover the glycerin in satisfactory condition from leys of this kind. Mr. A. H. Allen, of Sheffield, and Mr. B. Nickels, of London, patented a process * which is designed to overcome this difficulty. The process is based upon the fact that when a solution of a copper salt is added to soap leys previously rendered neutral or faintly acid, the sulphocyanides are wholly precipitated, together with sulphides, cyanides, ferrocyanides or silicates, as is also the case with albuminous, resinous, fatty, colouring, and other organic matters. The precipitate settles with great facility, and the filtered liquid is obtained nearly colourless, the copper being afterwards recovered from the precipitate by roasting and treatment with sulphuric acid. This process would appear to present considerable advantages in the treatment of spent leys, for it is well known that unless the whole of the sulphur compounds are removed, volatile sulphur compounds appear in the distilled glycerine, rendering the product totally unfit for the manufacture of dynamite.

Venables' Process.—The waste ley, which may be filtered if necessary, is neutralised with sulphate of alumina, alum, or any soluble salt of alumina, or any substance containing alumina, when the sodium hydrate or carbonate, combining with the acid, precipitates the alumina, which, combining with some of the organic matters, and carrying off the remainder, purifies the leys. The liquid is now to be filtered and concentrated by evaporation. Instead of merely neutralising, the salt of aluminium may be added till the ley becomes acid, and it may be afterwards rendered alkaline by the addition of caustic lime, or any other alkali. The spent leys may also be first partially neutralised by adding a small quantity of hydrochloric or sulphuric acid, and the remaining free sodium hydrate will then be neutralised by the aluminium salt, which may be added to

* Specification No. 11,069, August 31st, 1886.

neutralisation or to excess; in the latter case the liquid should be afterwards neutralised, or rendered alkaline. The glycerine may then be recovered by distillation as usual.

Modern German Method of Making Soap.—The boiling is conducted as follows:—The pan is charged with 190 gallons of soda ley of 13° B., and 2,000 lbs. of the best tallow. These are gently boiled for two hours after the mixture has become milky; the heat is then withdrawn, two hours' repose is allowed, and the ley is then run off. Boiling with fresh ley follows, and when the soap, on pressure between the fingers, forms clean solid scales, a few buckets of ley are thrown in to cool it, and again drawn off after setting for awhile. The soap is again boiled up with nine or ten gallons of fresh ley, and when the fusion is complete, a trial of the paste is made with the spatula. If it runs from the ley, water is added; if it does not run, it must be boiled a little longer, adding a bucket of water containing a third of its weight of common salt, in order to effect the separation of the soap. When this separation appears to be complete, after settling for about an hour, the liquid, which contains the greater part of the ley remaining from the first boiling, which is generally of a deep bottle-green colour, is drawn off. About eight buckets of water are now added and the boiling continued till the incorporation is complete. If on examination the soap runs from the water, more water must be added, in small quantities at a time, till the running ceases, and the pasty mass, when shaken, trembles like a gelatinous compound. The operation is finished by well-boiling the contents of the pan, and, unless the soap has a bluish tinge, in which case it should have another washing, the heat is withdrawn, the pan covered up, and the whole left at rest for a day or more. The soap is then ladled into frames.*

Removal of Free Alkali from Soaps.—In cases where it is desirable to obtain soaps free from uncombined alkali, various agents may be applied to neutralise the alkali, but it is preferable that the product resulting from

* Richardson and Watts' *Technology*, vol. i., part iii., p. 678.

the combination should in itself possess detergent properties, whereby the soap, while being rendered harmless so far as respects alkaline reaction, becomes improved as a cleansing medium. Upon this subject Dr. Wright, in his Cantor Lectures,* says: "It is obvious that the process of remelting and blending together various kinds of stock soaps is not capable *per se* of diminishing the average amount of free alkali present in the materials, but by the addition of suitable ingredients to the mass, more or less complete removal of free alkali may be brought about. In certain cases this is to some extent effected by incorporating with the mass a small percentage either of resin (alone, or dissolved in glycerine) or oleic acid, or even palm oil or other saponifiable glyceride, a partial saponification then taking place, so that the excess of alkali becomes more or less neutralised by combination with fatty or resinous acids; but these methods are by no means universally applicable with advantage, although, in certain cases they are highly convenient, more especially for scouring soaps used in certain industrial processes in connection with textile fabrics. Boric acid has also been employed for the purpose, the product of its combination with the excess of soda (borax) being well known as a useful variety of detergent analogous to silicate and aluminate of soda, more especially in soaps intended for the laundry, borax being reputed to have a whitening action on linen, &c., cleaned therewith; whether it is of equal advantage when applied to the human skin, however, may well be doubted.

"Certain metallic salts, notably sulphate of iron, have for many years been used as an admixture in various highly esteemed soaps, their action partly consisting in neutralisation of free alkali, by combination therewith of the acid of the metallic salt, whilst the metallic oxide is set free and serves as a colouring matter; thus "Castile" soap of the old-fashioned kind (a far superior article to much now sold under that name) is produced by adding sulphate of iron to the curd, so that some of the free alkali becomes converted into sulphate of soda, whilst the

* *Journal of the Society of Arts*, vol. xxxiii p. 1100.

oxide of iron, formed as a complementary product, ultimately gives rise to the peculiar mottled appearance characteristic of that kind of soap. Of course the modern mottles formed by incorporating oxide of iron as such, or analogous pigments, are incapable of producing any action of the nature of diminishing the free alkali by neutralisation, there being no constituent capable of so acting in the coloring matters used."

Transparent Soaps made by the Cold Process.—It is well known that tallow and similar soaps, when dried, are freely soluble in alcohol, and that the solution, when evaporated to expel the spirit, leaves the soap as a translucent mass, which, on cooling, forms the well-known transparent soap. The same result may, however, be obtained in a greater or lesser degree with some soaps prepared by the cold process; this is especially the case with castor-oil soda soap, either by the addition of a little spirit of wine or glycerine. The same result may also be obtained by mixing sugar or petroleum with the mass. "To so great an extent is this result effected," says Dr. Wright, "when a considerable amount of sugar is added (15 to 30 per cent.), that under suitable conditions tallow may be largely incorporated with the mass of fatty matter used without interfering with the transparency, provided that the saponification is carried out in such a fashion as to be complete, *i.e.* that no unsaponified stearic glyceride remains in the product, otherwise muddiness or spottiness is apt to result. In order to make sure that all the fatty matters employed are actually saponified, it is usual in this country to add a quantity of caustic soda solution, notably in excess of that chemically equivalent to the fatty acids, the excess as found by analysis of many kinds of commercial products, of British origin, usually varying from about $\frac{1}{7}$ to $\frac{1}{4}$ (15 to 25 per cent.) of the soda actually present in the form of soap. Some few makers, however (mostly Continental ones), prefer products containing much less free alkali than the smaller of these amounts. As a general rule, cocoa-nut oil largely enters into the composition of this class of transparent soaps, often with the result of com-

municating to the hands or objects washed with the soap a very disagreeable odour."

The following formulæ may be given as an illustration of the nature of the materials used in preparing this class of soap.* Melt the following with agitation: Cocoa-nut oil, 10 kilos.;† castor-oil, 10 kilos.; neutral tallow, 8 kilos.; and saponify them at 50° C. (122° Fahr.) with 14 kilos. of caustic soda at 38° B., and continue stirring until pastiness sets in. Add loaf sugar, 8 kilos.; and water at 85° C. (185° Fahr.), 8½ litres; ‡ taking care to bring it in gradually. As soon as the soap begins to solidify at the sides, the boiler is jacketed with a water-bath, kept at 80° C. (176° Fahr.), until it has attained the proper consistency, and the scum has separated. Add 20 to 30 per cent. of loading, agitate well, and then stir in a boiling solution of one kilo. of crystallized soda in one litre of water; dye, perfume, and finish off the batch as usual. The "loading" referred to is made from mineral oil and soap-shavings, the petroleum being previously deodorised by means of a solution of bleaching powder and hydrochloric acid, and afterwards treated with chalk to neutralise any acid present. 30 kilos. of the purified oil are heated to 50° C. (122° Fahr.), mixed with 2 kilos. of well-dried soap-shavings, and heated until a sample is found to solidify on cooling.

In reference to the above formula, Dr. Wright observes: "It is evident that even without the *loading* the resulting mass would not contain as much as half its weight of actual soap, for the ingredients consist of 28 kilos. fatty glycerides (representing a little more than the same weight of anhydrous soda soap—about 29 kilos.) and 32½ kilos. of water, soda and sugar, so that when 30 per cent. of loading is added, the resulting mass would not contain much more than one-third its weight of actual soap. On the other hand, the total alkali used (partly as caustic soda solution, partly as crystals) represents about

* *Journal of the Society of Chemical Industry*, April, 1883.
† A kilogramme equals 2 lbs. 3¼ ozs. nearly.
‡ A litre equals 34 fl. ozs. nearly.

113 per cent. of the amount chemically equivalent to the fatty matters, furnishing, consequently, a soap with an excess of *free alkali*, equal to one-eighth of that combined as soap, a quantity very far in excess of that compatible with good quality as regards injurious action on tender skin. The quantity of sugar prescribed represents some 13 per cent. reckoned on the mass without loading, and about 27 per cent. of the actual soap formed. This formula, apart from the loading, results in the production of an article of distinctly better quality than most of the transparent soaps of this kind now sold in Great Britain, for these soaps usually contain a still larger excess of alkali (ranging from 15 to 25 per cent., and even more being often found); whilst the amount of actual soap in tablets fresh from the factory (and not dried by exposure in shop windows) rarely exceeds 45 per cent., so that these articles are about as much a compound of sugar candy and soda crystals as they are soaps, if not more so."

In the market these soaps are commonly known as *transparent glycerin soaps*, and they may be prepared from either of the subjoined formulæ:—

I. Melt together suet and Ceylon cocoa-nut oil, of each 500 parts; castor oil, 250 parts; palm oil, 50 parts, and glycerin 500 parts. Saponify the mixture at about 167° Fahr., with soda ley of 1·38 sp. gr., 500 parts. The solution of soda should be added gradually, and the whole kept well stirred while the saponification is progressing, which will occupy about five minutes. The resulting soap is then removed from the melting pan and mixed with 600 parts of strong alcohol or methylated spirit, the whole being well agitated until quite clear. 150 parts of simple syrup are then added, as also the necessary perfumes, and the soap is then put into moulds.

II. Tallow, 20 lbs.; palm oil, 12 lbs.; castor oil, 8 lbs.; soda ley, at 38° B., 20 lbs.; 96 per cent. alcohol, 20 lbs.; glycerin, 20 lbs., and sugar, 5 lbs. dissolved in water, 5 lbs. The tallow and palm oil are first melted, and the ley next added, and saponification effected as usual, with stirring, the alcohol is then added, and when this has

become well incorporated, the glycerin is added. The soap may be perfumed with bergamot, 250 grains; citron, 90 grains; lavender, 20 grains; neroli, 30 grains; rosemary, 5 grains, and a few drops of otto of roses dissolved in 1 lb. of 96 per cent. alcohol may be added if desired, and the soap coloured with saffron substitute.

III. Melted tallow, 209 lbs.; caustic soda ley at 40° B. 94·6 lbs., and alcohol 110 lbs. One half of the alkali is to be added to the melted tallow, the heat being kept as low as possible—about 120° F. When, with constant stirring, the ley has thoroughly combined, the remainder of the ley (to which the alcohol has been previously added) is next introduced, and the heat well regulated; saponification takes place rapidly. Now add the perfume, cool, pour into the frames, and continue the cooling very gradually. The transparency will not be apparent until the soap has been exposed for some time to the air. To perfume the above 2·2 lbs. of mixed essences may be used.

Mialhe's Neutral Soap.—M. Mialhe describes a soap which he states combines the advantages of being prepared without heat, and thus avoiding the loss of the *glycerin in combination with the fatty matters*, and of being free from that alkalinity generally present in soaps prepared in the cold. In its preparation the ordinary toilet soap, made without heat, is cut into shavings and exposed, in a properly closed chamber, to the action of carbonic acid gas. The soap absorbs a quantity of the gas proportionate to the quantity of caustic soda which has escaped saponification, and by the transformation of the free alkali into bicarbonate, it loses all its causticity. It then constitutes a perfectly neutral soap, containing all the glycerin of the fatty bodies employed in its manufacture, and a certain quantity of bicarbonate of soda.

Samphire Soap.—This soap, recently patented by Messrs. Field, of Lambeth, London, consists of palm oil and olein, saponified with iodized potash, obtained from the ashes of seaweed. The resulting soap is subsequently milled, after completely expelling the water, and it is de-alkalised by the introduction of an ammoniacal salt.

Dr. Wright's Classification of Soap Processes.—In his Cantor Lectures* Dr. C. R. A. Wright classifies the various processes for the manufacture of soap as follows:—

Group I.—Fatty or resinous acids in the free state directly neutralised with alkalies (carbonated or caustic); resulting soap devoid of glycerin.

Group II.—Saponification of fatty glycerides by alkalies, with retention of glycerin intermixed with the soap. In this group are the processes for making (*a*) soft soaps and marine soaps by *open boiling*, (*b*) soaps made by *boiling under pressure*, (*c*) *cold process* soaps.

Group III.—Saponification of fatty glycerides by alkalies with separation of glycerin.

Group IV.—Processes consisting of combinations of the foregoing.

It will be seen from a consideration of the above that the *methods* may be arranged under three main heads, viz., *open boiling*, *boiling under pressure*, and the *cold process*.

Marine Soap, or Hydrated Soap.—The saponification of cocoa-nut oil, which is the fatty basis of this soap, requires considerable care and judgment in its manipulation. In the first place the process of saponification takes place very tardily, even under most favourable conditions, but as soon as the chemical combination of the fatty material with the ley has fairly set in the saponification proceeds with great rapidity, causing the mass to swell up considerably; a very deep pan is, therefore, absolutely indispensable in the preparation of this soap. It is also necessary to employ a strong ley at the commencement—about 20° B., since cocoa-nut oil cannot be saponified with weak leys. The caustic soda should also be as pure as possible and well causticised. Sometimes potash ley is used in addition to the soda ley, as it is found to greatly assist the saponification. The separation of cocoa-nut oil soap can only be effected by a very strong solution of common salt, since it is soluble in *dilute* brine, a fact which renders it suitable for washing in sea-water. If cocoa-nut oil soap be separated with salt the resulting finished soap becomes

* *Journal of Society of Arts*, vol. 33, 1885.

so exceedingly hard that it cannot be cut with a knife. The cutting of the pan with salt is not, however, practised with this soap.

Cocoa-nut oil has the remarkable property of combining with large quantities of water and still yield a soap of considerable hardness. This fact is extensively taken advantage of in the preparation of "liquored" soaps, the oil being mixed with palm and other oils, forming soaps which are artificially mottled a blue or grey colour, and sold at a low price. It is even possible* to prepare soap on a large scale in a few hours without salt and almost without fire by the use of cocoa-nut oil and tallow, together with strong ley, by merely warming them sufficiently to melt the fat and keeping them constantly in a state of agitation. Soap prepared in this manner has a finer appearance, and sets in the mould so that it can be cut. It contains, however, nearly all the water of the ley, as there is very little evaporation in the pan, together with the entire amount of foreign salts, and, in a fresh state, has less resemblance to soap than stiff dough, taking deep impressions from the thumb, and having a slimy consistence when squeezed between the fingers. When dried for a length of time there is a copious efflorescence of salts, but it finally acquires the consistence of ordinary soap. Marine soaps are often met with containing 70 per cent. of water and even more.

Blake and Maxwell's Process.—By this process a soap is produced by combining soap in the state called "soft curd," with a *hydrated soap*, or neutral soap not deprived of its water. The curd soap may be prepared as usual, but the patentees prefer that it should be made with soda leys of the strength and in the proportions given below, whereby a soft curd is obtained which is better adapted for combining with neutral soap. The soap thus formed may be separated from the water, or excess of ley, by cutting the pan in the usual way either by means of salt or strong leys. The resin soap is prepared as follows:—About one-third of the resin to be used is mixed with a

* Richardson and Watts' *Technology*, vol. i., part iii., p. 683.

small quantity of fatty matter, equal to from 6 to 10 per cent. of the resin, and the mixture slowly melted. The remainder of the resin is then added gradually, by small portions at a time as the added portions melt, and when the whole is melted the rest of the ley is introduced. The heat is then increased till the mixture boils, and the boiling continued for about three hours, or until saponification is complete, when the mass will have the consistence of thick glue or paste. The *hydrated soap* is prepared in another pan from any of the fatty matters mentioned below, either singly or in combination, and to it are transferred the soft curd, resin, and tallow soaps. These soaps, after boiling together for about two hours, will become thoroughly combined, and the compound soap will have the appearance of ordinary soap in process of finishing. The soap should be removed to the frames within two or three hours after it is finished, and the frames should be covered so as to retain the heat as long as possible.

The following table gives the oily and fatty matters which may be used for making the *soft curd*, and the strength and quantity of the soda leys most suitable for specially effecting their saponification. The weight of ley required to saponify each 100 lbs. of fatty matter may be found by dividing the number of degrees by the strength of the leys applicable to each kind of fat.

Fat to be used.	Quantities of ley in degrees Baumé.	Strength of ley in degrees Baumé.
100 lbs. of tallow require . .	3,800°	14° to 15°
,, palm-oil ,, . .	3,200°	16° ,, 18°
,, tallow olein ,, . .	2,800°	16° ,, 18°
,, resin ,, . .	2,700°	16° ,, 22°

The oils and fats that may be used for making the *hydrated soap* and the quantity and strength of the leys required for saponification are:—

Fats to be used.	Quantities of ley in degrees Baumé.	Strength of ley in degrees Baumé.
100 lbs. of tallow require . .	3,830°	11°
,, cocoa-nut oil,, . .	4,100°	16° to 20°
,, palm oil ,, . .	3,200°	18° ,, 22°
,, lard ,, . .	3,400°	13°
,, tallow olein ,, . .	2,800°	18° ,, 22°
,, olive oil ,, . .	3,000°	16°
,, rapeseed oil ,, . .	2,400°	24° ,, 28°
,, linseed oil ,, . .	2,400°	24° ,, 28°

Testing Soaps (*Filsinger's Method*).*—1. *Water.*—In the case of *hard soap*, 5 grams, scraped from the sides and centre of a fresh section, are first very gently warmed to avoid direct melting, then over a water-bath, and finally in a drying-box at 212° Fahr., until the weight remains constant. For *soft soap*, 10 grams are taken, spread in a thin layer over a large watch-glass, and treated in the same way.

2. *Unsaponified or Free Fat.*—The dry residue from 1 is finely powdered and washed on a filter three or four times with lukewarm petroleum ether. The filtrates are collected in a weighed beaker, evaporated, dried, and weighed.

3. *Free Alkali.*—The residue from 2 is digested for a short time with alcohol (95 per cent.), slightly warmed, filtered, the residue on the filter, washed with warm alcohol, and the filtrate, to which a few drops of phenolphthaleïn solution are added, titrated with $\frac{n}{10}$ sulphuric acid.

4. *Foreign Bodies.*—These are found by the usual methods, together with the chlorides, sulphates, and carbonates of the alkalies on the filter in 3.

5. *Fatty Acids.*—The neutralized alcoholic solution from 3 is mixed with water in a moderate-sized porcelain basin, the fatty acids separated by sulphuric acid, and after melting and settling, 5 grams of dry wax are added. When the whole is cool, the fat-acid wax is removed,

* *Chemiker Zeitung*, 1884, and *Chemist and Druggist*, 1884, p. 290.

washed with water and alcohol, dried without melting, and cooled. The weight, 5 grams = the quantity of fatty acids.

6. *Glycerin.* — The liquid from the cake of fatty acids is treated with a small excess of carbonate of barium, heated, filtered, the filter washed with hot water, and the filtrate evaporated to dryness. The residue is repeatedly washed with alcoholic ether, the filtrate evaporated in a porcelain dish, dried at the temperature of 70° C., and weighed.

7. *Total Alkali.*—10 grams of another portion of soap, prepared as in 1, are dried in a platinum dish, and then heated till all the fatty acids have been destroyed; the porous carbonaceous residue is boiled in water, filtered into a ¼-litre flask, and the filter washed with hot water till the washings cease to give an alkaline reaction. The bulk is then made up, the whole well mixed, and 25 c.c. (= 1 gram of soap) of the solution are titrated with sulphuric acid. The result represents the total amount of alkali, and, after deducting the quantity of free alkali formed by 3 the remainder is the proportion of alkali combined with fatty acids, and existing as carbonate and silicate.

8. *Chlorine.*—The neutral titrated solution from 7 may be used for the determination of chlorine by $\frac{n}{10}$ silver solution.

9. *Silicic Acid.*—75 c.c. of the solution from 7 are treated with excess of hydrochloric acid, evaporated to dryness, treated with water, filtered, and the residue ignited and weighed as silica.

10. *Sulphuric Acid.*—The filtrate from 9 is boiled, and, while boiling, barium chloride is added, the precipitated barium sulphate washed, dried, and weighed, and calculated as sodium or potassium sulphate.

11. *Potash and Soda,* if both are present, must be determined in the usual way by platinum chloride.

Determination of Glycerin.—The presence of sugar in soap renders the determination of glycerin somewhat difficult. Dr. Wright, however, recommends the following method, which is said to give fairly accurate results:—

The aqueous solution left after the separation of the fatty

acids, as before described, is rendered strongly alkaline with a solution of caustic soda, and then a dilute solution of sulphate of copper is dropped in, with stirring, until the hydrated oxide of copper thus formed begins to fail to dissolve. The filtered blue solution is compared calorimetrically with a known quantity of a standard solution of glycerin treated side by side in the same way. When sugar is present, the alcoholic extract, obtained as above, must be heated with dilute sulphuric or other acid for some time, so as to *invert* the sugar. The fluid is then rendered alkaline, and solution of sulphate of copper dropped into the boiling liquid as long as suboxide of copper is reduced, after which the calorimetric estimation of the glycerin is proceeded with as before, the comparison being preferably made with a known solution of glycerin and cane sugar treated simultaneously with the sample under examination.

*Dr. Muter's Method.**—This method may be used for the determination of glycerin in soap and soap leys, the process being based on the power of glycerin to arrest the precipitation of copper hydrate by the alkalies. The procedure is as follows:—

1. Take 1 gram of absolute glycerin and wash it into a long, stoppered, graduated tube, having a stop-cock at 50 c.c. from the bottom.

2. Add 50 c.c. of a strong solution of potassium hydrate (1 in 2) and then a weak solution of sulphate of copper, very gradually, and with constant shaking, until a fair amount of copper hydrate is produced which remains undissolved; make the whole up into a given bulk, close the tube, and set aside to settle.

3. When perfectly clear, run off from the tap into a beaker a given volume of the deep blue liquid, and add to it the slightest possible excess of nitric acid.

4. Pour in a definite excess of ammonium hydrate, bring the beaker under the burette charged with volumetric solution of potassium cyanide, and run in till decolourised.

* *The Analyst*, 1881, p. 41.

The number of c.c. of the cyanide used, after calculating to the whole bulk originally in the tube, represents 1 gram of glycerin. The result has, however, to be corrected by going through a blank experiment with the same amounts of everything, but *without the glycerin*, and deducting the c.c. of cyanide taken from that previously formed. This precaution is necessary because copper hydrate is not quite insoluble in the strong alkali, but, once made and deducted, the difference gives the true value in glycerin of the cyanide solution, and, when that has been thus standardised, any number of estimations can quickly be made. The glycerin to be determined must first be isolated, as free from intermixture as possible, as previously described.

Determination of Resin in Soap.—The method proposed by Gladding* is as follows:—About 0·5 gram of the mixture of fatty acids and resin are dissolved in 20 c.c. of strong alcohol, and, with phenol-phthaleïn as an indicator, soda is run in to slight super-saturation. The alcoholic solution, after boiling for ten minutes, to ensure complete saponification, is mixed with ether in a graduated cylinder till the volume is 100 c.c. To the alcoholic and ethereal solution 1 gram of very finely powdered neutral silver nitrate is added, and the contents of the cylinder are shaken thoroughly for ten or fifteen minutes. After the precipitate has settled, 50 c.c. are measured off, and, if necessary, filtered into a second graduated cylinder. A little more silver nitrate is added to see if the precipitation is complete, and then 20 c.c. of dilute hydrochloric acid (1 : 2) to decompose the silver resinate. An aliquot part of the ethereal solution is evaporated in a tared dish and weighed as resin, deducting a small correction (0·00235 gram for 10 c.c.) for oleic acid. The amount of resin subtracted from the combined weight of fatty acids and resin, as found before, gives the fatty acids.

Eichbaum's Soap.—To make soap from strong-smelling fish fats, F. Eichbaum takes 400 kilos. of the fat, 25 kilos. raw palm oil, 250 kilos. of ley of 12° B., and warms up. A further similar amount of ley of 15° B. is added, and

* *Chemical News*, April 14th, 1882.

the mass, after being thoroughly mixed by agitation, is allowed to boil till clear and free from scum, an addition of ley being made when necessary. The mass is then poured in a thin stream through 20° ley, 50 kilos. powdered resin are added gradually, and then 40 kilos. of ley of 20°, and the mass boiled. When ready, the soap is salted in the ordinary way. The addition of resin is said to considerably lessen the fishy smell.

Soaps for Calico Printers and Dyers.—According to Scheurer * a soap for brightening colours such as alizarin, or garancin, should first of all produce a perfectly white ground, upon which the colour then appears much more brilliant, and in the second place it should not attack the colour itself. On comparing from this point of view the various soaps occurring in commerce the Marseilles soap was found to be the best, although the reason for this superiority was not at first obvious. A soap which attacked the colours used to be regarded as too alkaline, but on analysis it was found to contain no more alkali than the best soaps. It was especially the oleic acid soaps which exhibited this injurious alkalinity, attacking all shades of colour. This behaviour is attributed by Scheurer to the fact that many so-called alkaline soaps made with oleic acid simply contain both free oleic acid and free alkali, because the saponification has not been complete. Such soaps may be perfected by continuing the boiling. It should be remembered that the combination of the acid and soda requires a considerable time—two kinds of soap, an *acid* soap and a *basic* one, seem to be produced at the beginning of the process, and these gradually unite to form a neutral soap. The reaction can be hastened either by increasing the temperature or pressure, thus, at a pressure of 1·5 atmosphere, Scheurer found that a better soap was obtained in two hours than in twelve hours under ordinary pressure. A soap manufactured by Daumas D'Alléon, of Marseilles, is recommended as the type of that best suited for dyeing and printing purposes. It is composed as follows:—

* *Journal of the Society of Chemical Industry*, 1883, p. 286.

Fatty acids 55, caustic soda 6, water 39, total 100; or 9·106 parts caustic soda to 100 parts of fat.

At the Zawiercie Works the following method is adopted, it is said with success, for the manufacture of soap suitable for printing and dyeing:—About 360 litres of water and 69 kilos of ley at 36° B. are boiled up together, and 140 kilos of oleic acid added with constant stirring till a uniform mixture is obtained, 3,120 litres of water are then added, and the mixture is well stirred till a clear soap solution results. When the above proportions are used, the oleic acid is sometimes found to be in excess, and some more soda must be added. To prevent this a little more soda should be added at the beginning.

Soap for Silk Dyers.—According to Morfit the soap most suitable for stripping and boiling off the gum from silk is a brown-oil soap, which should cleanse readily without injury to the silk, and be easily rinsed out. Sulphate of soda is usually added to this soap. In the north of Europe soft potash soaps—generally prepared from linseed oil—are used, and in the south hard soda soaps made from olive and other oils are used by preference. Soaps made from oleic acid have of late years been much used by silk dyers, and it is found that those which are made from oleic acid and linseed oil wash off best, while those prepared from olive oil and tallow come next in this respect; soap made from palm oil does not rinse off so well. Oleic acid soap is most suitable for scouring silk to be dyed, but for silks which are to remain white a good olive oil soap is to be preferred.

The late Prof. Crace-Calvert, who had a very long scientific experience in this industry, held that the soft soaps usually made for dyers' use are not indiscriminately applicable to all colours. To produce the maximum effect in brightening the shade the soap should be composed of:—

	For madder colours	
	purples.	pinks.
Fatty acids	60·4	59·23
Soda	5·6	6 77
Water	34 0	34·00
	100·00	100·00

Soap Leaves are prepared by passing continuous paper sheets over rollers through a hot solution of soap, the excess of soap attached to the surface being scraped off. The paper is then passed over drying cylinders and from thence to a cutting machine.

Zalmon's Aromatic Mouth Soap.*—1 lb. of neutral soap, prepared from fat of the best quality, is dissolved in cold distilled water, about 3½ ozs. finely sifted cuttle-fish bone are added to the solution, and the whole evaporated at a gentle heat. When the desired consistency is nearly reached add three-quarters of a drachm each of oil of peppermint, oil of sage, virgin honey and white vinegar, or oil of lemons. Mix the whole quickly by stirring, and pour into suitable moulds to cool. Colouring matter may be added as desired.

Aromatic Antiseptic Tooth Soap.—Castile soap 1 lb.; finely-powdered pumice, 1 oz.; thymol, 20 grains; oil of wintergreen, 30 drops. Shave the soap into ribbons, beat it into a paste with a little water, and add first the pumice and next the thymol and wintergreen dissolved in a small quantity of alcohol.

Unna's Over-fatty Soaps.†—These soaps are specially designed for employment in cutaneous affections. In commencing his experiments Unna first prepared a normal soap of fixed composition, which could be incorporated with various medicinal substances. While, theoretically, he considered that beef fat was the most perfect, he found, practically, that an advantage was gained by adding 1 part of olive oil to 8 parts of beef fat. The alkalies employed were soda 2 parts, and potash 1 part, this combination being less apt to blister when medicinal substances were added to the soap. Cocoa-nut oil, though producing a soap which lathers well, was found to make the skin dry after continued use. Even a neutral soap, when constantly used, tends, according to Unna, to produce an unpleasant roughness, from removing too completely the natural oiliness of the skin—a

* *Chemist and Druggist*, 1880, p. 13.
† Edinburgh *Medical Journal*, 1885.

view, we should think, that will not be very readily accepted. He therefore leaves the soap *over-fatty*, that is, besides the fat necessary for perfect saponification, an excess amounting to 3 or 4 per cent. is added. Any secondary addition of glycerin or vaseline he entirely rejects. This soap he terms *over-fatty normal soap;* it may be used as an ordinary washing soap in all forms of inflammatory skin diseases where ordinary soap is forbidden, as in eczema, erythema, and for skins poor in fat with a tendency to dryness; also as a soap for healthy people whose occupation compels them to wash frequently in the course of the day.* The composition of the soap is as follows:—

16	parts best ox fat	59·3
2	,, olive oil	7·4
6	,, soda ley (38° B)	22·2
3	,, potash ley	11·1
27		100·0

In this soap about 4 per cent. of oil remains unsaponified. It is of a yellowish-white colour, of a waxy consistence, and quite permanent. It forms an exceedingly good soap for children, and if rubbed on the hands and wiped off again in a few minutes with a dry towel, it leaves the hands smooth, and little liable to be injuriously affected by damp, cold, or long-continued contact with carbolic acid. It will be readily seen, however, that the unsaponified fatty matter remaining on the skin after the above treatment will quickly be converted into fatty acids, emitting a disagreeable odour, while, possibly, they would cause irritation to delicate skins.

Over-fatty Marble Soap is prepared from equal parts of the above soap and the finest powdered marble, and it is said that it will be found useful in thinning down the horny layer of acne, thus replacing pumice-stone and sand-soap, and, while powdered marble rubs off the scales or thickened epidermis, the over-fatty normal soap leaves the polished surface smooth and "normally unctuous"!

* We should fancy that the detergent properties of such a soap would be little, while its antiseptic powers would be nullified by the free fat.

Dimbleby's Wych-hazel Soap.—The juice of the plant *Hamamelis virginica*, or common wych-hazel, is mixed with soap, and the various compounds for toilet purposes which contain soap, and it is said that such compounds are beneficial in cases of bruises and lacerations of the skin.

Castor Oil Soap.—This soap, prepared as below, is said, by Mr. Hammer* to answer best for preparing soap liniment (*Linimentum Saponis Co.*):—

Saponify 2 pints of castor oil with 6 ounces of caustic potash and 2 pints of water, by heating until a transparent mixture is obtained; then add a saturated solution of 8 ozs. of chloride of sodium, stir until cool, allow to subside for a day, decant the liquid portion, cut in pieces, and dry for use.

Weise's Formula for Windsor Soap.—Tallow 40 lbs. and olive oil 15 to 20 lbs., are saponified with soda ley of 19° B.; the soap next treated with a ley of 15° B., and lastly with a ley of 20°, and the operation is conducted as for curd soap, but no excess of alkali must be used. When boiled clear, the soap is left in the pan for six or eight hours; it is next completely separated from the ley, and is then placed in a flat mould, and pressed until it no longer exhibits any flux, to prevent it from mottling. To the above proportions the following perfumes are added:—Oil of cumin, 10 oz.; oil of bergamot, 6 oz.; oil of lavender, 3 oz.; oil of origanum, 1 oz., and oil of thyme, 3 oz.

Rendering Tallow.—At some soaperies it is the custom to clarify or *render* their own fats, whereby they obtain perfectly pure tallows, while at the same time effecting some advantages in the way of profit. This operation is more especially a necessary part of the manufacture in districts where crude fats are abundant. The operations of *rendering* tallow are: 1, drying the fat; 2, mincing; 3, boiling or melting. The rough fats, or suets, as they come from the slaughter-houses are suspended from beams in a well-ventilated loft until sufficiently dry, after which

* *Year Book of Pharmacy*, 1883, p. 313.

they are minced either by a hand cutting-machine or by a machine driven by steam power. The minced fat is afterwards boiled either in an open pan heated by fire from below, or more properly, in a jacketed pan heated by steam. When an open copper is used it is absolutely necessary that the fire should only play upon the bottom of the vessel, otherwise the fat will be liable to become charred and discoloured. It is usual to first put into the pan a certain amount of water and rendered tallow, and when this is melted the minced fat is gradually introduced with constant stirring, and the heat gently kept up until the whole of the fat is liquefied: the melted fat is then passed through a wicker or wire sieve or basket, and then allowed to rest for some time to allow fibrous and other impurities to subside. The tallow is then transferred to casks or tubs for future use. The solid residues retained by the sieve, called *greaves* or *cracklings*, are afterwards enclosed in canvas bags and submitted to moderate heat, and gradually increasing pressure, by which a further quantity of tallow is extracted.

The process of rendering tallow by boiling the fat in an open pan is open to several objections, amongst which may be mentioned the difficulty of keeping up a uniform heat; again, the animal tissues which are attached to the fat do not become thoroughly broken up, but assume a very hard condition, which renders it impossible to press out the whole of the tallow. To overcome these difficulties and objections, it is generally the custom in large establishments to boil by steam, and in order to break up, and to some extent dissolve, the membranous and other tissues, certain chemical substances are employed—an idea that originated with the late Mr. Charles Watt, who, as far back as the year 1830, devoted his attention to this subject, and subsequently—namely in 1836—obtained a patent for refining tallow, which consisted in the employment of dilute sulphuric acid, with a little nitric acid and bichromate of potassa. This process, subjected to some modifications, has been, and still is, generally adopted in the rendering of fats for soap and candle-making.

By D'Arcet's method, the crude fat is boiled by steam, with about one-fourth its bulk of water, acidulated with 2 to 3 per cent. of sulphuric acid, in an open or loosely-covered lead-lined vessel. By another method a steam-tight cylinder is employed, in which the fat is subjected to a pressure of 50 to 60 lbs. per square inch, the boiling

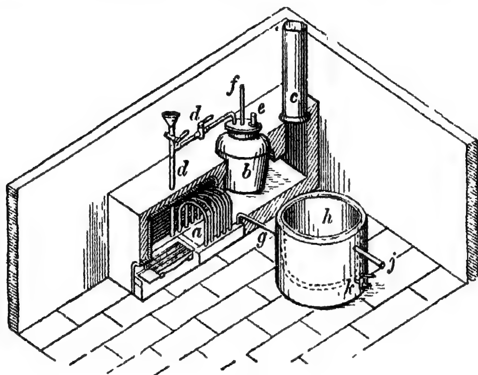


Fig. 37.

being kept up for about ten hours. It is said that by this method 12 per cent. more tallow is obtained than by any other method adopted. Another process consists in keeping the tallow melted for some time, about 2 per cent. of oil of vitriol, largely diluted with water, being added, and the whole is kept constantly agitated. The tallow thus treated is allowed to cool slowly, and the resulting cake is afterwards remelted with a large quantity of boiling water, to remove all traces of the acid. A very effectual way of washing out the acid is to blow steam through the liquid fat, for half-an-hour or so, and when the steam is shut off, to keep the pan covered up, so as to retain the heat as long as possible, by which means the condensed steam, carrying traces of acid with it, gradually subsides, leaving the tallow free.

A very effective method of rendering tallow is obtained by means of Messrs. Merryweather & Sons' patent superheating apparatus, an illustration of which is shown in

Fig. 37. The apparatus is stated to present the following advantages over the method of melting by fire-heat:—1, The copper is not injured by local heat, and will last for many years; 2, there is little risk of burning the tallow or fat during the heating; 3, the pan costs 50 per cent. less that those ordinarily used; 4, the pan can be instantly checked, thus preventing the danger of boiling over; 5, no risk of accidents from fire; 6, economy of fuel. The following are the details of the apparatus:

a is the superheater, formed of wrought-iron lap-welded tubes, set in a brick oven with ordinary furnace bars, as shown.

b is the steam boiler, the water in which is kept to its proper level by means of a self-regulating feed.

c is the chimney.

d d are the pipes and cocks connecting the boiler with the superheater.

g is the pipe which connects the superheater with

h, the fat-pan, which is set in brickwork, to prevent loss of heat.

In cases where it is essential to destroy obnoxious fumes arising from the melting process, a patent cover is provided for the fat pan, *h*.

Silicates of Soda and Potash.—*Way's Process.* This process is described in the specification of the patent as follows:—

"I put into a suitable pan, heated by steam or in any convenient manner, a quantity of caustic alkaline ley (potash or soda, or both, as the case may be) of about 18° Tw., so that the silica solution when made shall have a gravity as nearly 36° as possible, and after having raised this ley to the boiling-point I add by degrees the rock or clay,* either in small pieces or ground to powder, until the alkali has taken up as much silica as it will dissolve. The heat is now withdrawn and the undissolved earthy matter is allowed to settle. The clear liquor is run off, and a fresh quantity of water is added to the sediment

* A product found in Surrey and containing sometimes as much as 70 per cent. of silica.

to wash out further portions of soluble matter. The liquors so obtained are solutions of alkaline silicates. The quantity of rock or clay required will vary with the percentage of soluble silica which it contains. I find it necessary for every 31 parts of actual soda, or 53 parts of carbonate of soda rendered caustic, to employ as much of the rock or clay as contains 78 parts of soluble silica.

"I produce similar alkaline silicates from the rock or clay by gently heating it in a furnace with alkalies or alkaline carbonates. In this case, combination of the materials and production of the alkaline silicates takes place at a temperature much below that which is necessary when other forms of silicious matter are used, and though preferring the method formerly mentioned for the treatment of the rock or clay the one last described may be employed. The alkaline silicate is dissolved out from the furnaced materials by water or alkaline ley. I prefer, in either case, to saturate the alkali as fully as possible with silica, but this is not absolutely necessary. The silicates so produced are more suitable for the soap-maker, for the following amongst other reasons:—1. They are more economically produced. 2. The caustic property of the alkali contained in them is more perfectly neutralised. 3. They contain no iron, alumina, or other matter injurious to soap. 4. The soap produced by them is therefore of superior quality, as well as cheaper. The alkaline silicates produced by either of these processes may be employed in any of the modes now used by soap-makers in incorporating the silicates of the alkalies with soap.

Barring Soap by Machinery.—A very useful machine * for cutting soap into bars is shown in Fig. 38, and consists of a fixed frame of wood-work, A A, and a movable lever-frame, B B, attached to A A by the centre pin C. The frames are wide enough to receive a slab of soap 45 ins. long by 15 ins. wide. This is placed in an inclined position, as shown by the dotted lines resting on the bar D of the fixed frame, and against a series of wires stretched upon

* Richardson and Watts' *Technology*, vol i., part iii., p. 664.

the movable frame. When the lever G is pressed down the wires pass through the slab of soap, dividing it into regular bars, and when the handle is again raised up to the position shown in the cut the bars are found on the table F ready to be removed.

Ammoniated Soap.—The subjoined formula is given in the *Journal of the Society of Chemical Industry* :*—A soap is first formed in the usual way from the following ingredients :—Stearic acid, 8 parts ; cocoa-nut oil, 4 parts ; potash and soda, of each 1 part ; water, 6 parts. The

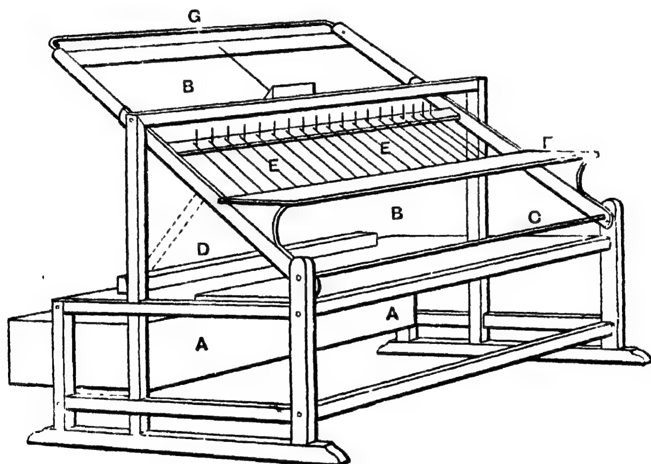


Fig. 38.

soap, when cold, is cut into shavings, which are then placed in a retort, in which they are subjected to the action of gaseous ammonia at a pressure of 15 lbs. per square inch, until the soap has become thoroughly impregnated with it.

Way's Silicated Soap.—To produce 100 lbs. of soap, the operator puts into the soap-pan 11·5 per cent. of each, bleached palm oil and cocoa-nut oil, and 36·6 per cent. of soda ley of 36° Tw. These ingredients are boiled till the

* Journ. Soc. Chem. Indus., 1883, p. 181.

soap becomes stiff, and there is then added 44 per cent. of solution of silicate of soda of 36° Tw. The boiling is now continued till the soap becomes thin and limpid, when 2·4 per cent. of common salt is thrown in, and the boiling continued for three or four hours, when the soap may be cleansed either at once or after it has been allowed to stand for a few hours. If *open* steam be used it is best to have the silicate solution and the ley of greater strength than that mentioned, in proportion to the quantity of water which is condensed from such steam into the soap-pan.

Blue and Grey Mottled Soaps.—For preparing these soaps, which are much patronised in the north of England, two soap-pans are required. In one pan a *fitted* soap is prepared from tallow and palm-kernel oil or cocoa-nut oil, which is afterwards removed to the second pan, and for every 1,000 lbs. of soap are added 250 lbs. of silicate of soda solution, the whole being thoroughly incorporated by boiling, until the soap-boiler judges that the proper condition for mottling has been reached. The colouring matter—ultramarine for blue mottle—worked up into a thinnish paste with water, is then sprinkled over the surface of the boiling soap a little at a time until the full quantity has been introduced; the proportion of ultramarine per ton of soap is from 5 to 10 lbs. If the soap be in too liquid a state the colouring matter is apt to permeate the entire mass, giving it a blue tint throughout, and the desired mottled appearance will not be attained. When properly conducted the blue pigment shows in the soap in blue patches, which appear in strong contrast to the white ground of the soap, giving it a pleasing appearance to the eye. The grey mottled soap of the same class is coloured with finely powdered oxide of manganese, from 1 to 3 lbs. to the ton, introduced in the same way as above.

A red mottled soap is also produced with vermilion.

Fulling Soap.—The following formulæ are given by Mr. Kingzett* for a soft soap to be used for cleansing and scouring woollen fabrics:—

* *Alkali Trade*, p. 175.

	I.		II.
Fatty Acids	50.0	....	40.0
Potash	11.5	....	9.5
Water	38.5	....	50.5

The soap should contain a slight excess of alkali, but no resin (which hardens the fabrics), starch or silicate should be present.

Soap to Remove Stains.—This is prepared from a good white soap, cut into thin shavings. For 6 lbs. of the soap take one ox-gall, and the whites of four eggs, and mix all the ingredients in a mortar, adding 2 lbs. of powdered alum. When the whole has been well incorporated, the mass is to be kept in a damp place for twenty-four hours. It is said that this soap finds much favour with scourers for removing grease, &c.

Cotton-seed Oil.—This oil, which is largely manufactured in the Southern States of America, is a good deal used as a soap material, especially in the north of England. In its crude state it is of a darkish colour, and somewhat viscid, but when purified it is clear and almost colourless. The crude oil, being much cheaper than the refined article, is preferred by soapmakers. The oil does not of itself make a good hard soap, but when mixed with other materials, in the proportion of about one-third, it forms a useful soap material, and a good soap may thus be obtained. There are some peculiar difficulties in the employment of cotton-seed oil for soapmaking, however, if it be used in considerable proportions; for example the cutting of the pan, or separation of the soap by common salt, does not take place so readily as usual, but this is overcome by adding water to the pan. The colour of the soap may be improved by boiling the soap over spent leys containing carbonated alkali.

Chlorinated Soap.—Powdered Castile soap 11 oz. and dry Chloride of Lime 1 oz. are beaten into a mass with sufficient Rectified Spirit, holding in solution Oil of Verbena, or of Ginger-Grass, $\frac{1}{4}$ oz. The mass is then formed into flat tablets, and wrapped in thin sheet gutta-percha.

Commercial Value of Soaps.—Dr. Buchner gives a

method by which the amount of hard soap in a sample may be calculated from the amount of fatty acids obtained when a given quantity of the sample is decomposed by strong acid. He uses a flask, the neck of which is graduated into cubic centimetres; into this flask, half filled with water, he puts half an ounce of the soap and dissolves it. He then adds the acid, either commercial hydrochloric acid or dilute sulphuric acid; and warms the mixture, when the fatty acids are set free. He next adds sufficient water to allow the reading of the cubic centimetres the acids measure in the neck of the flask. The fatty acids from different sources differ slightly in specific gravity, but Dr. Buchner found that the average weight of a cubic centimetre is 0·93 gramme, which is practically near enough. As the acids are combined with $\frac{1}{16}$ of glycerin, it is easy, knowing the weight of the acids, to calculate the weight of the fat used; and as on the average 100 lbs. of fat give 155 lbs. of good hard soap, the weight of the real soap can be calculated when the weight of the fat is known. These calculations may be made by using the table given below. The results, however, are not to be considered scientifically accurate, but near enough for ordinary business purposes. The method only requires one weighing, is executed in a few minutes, and is so simple that it can be performed by an ordinary workman.

I. Cubic centimetres of fat acids separated from half-an-ounce of soap.

II. Percentage of water, ley, glycerin, &c., in the sample.

III. Percentage of good hard soap.

I.	II.	III.
½	97	3
5	69	31
6	63	37
7	57	43
8	51	49
9	44	56
10	38	62
11	32	68
12	26	74
13	20	80
14	13	87
15	7	93

APPENDIX B.

MODERN CANDLE-MAKING.

FORMERLY, and indeed well within the memory of the writer, candle-making was a rude and exceedingly offensive trade, and the effluvia from a "fat-loft"—especially during the summer months—rendered the precincts of a tallow-chandler's establishment not only offensive to the nose, but highly prejudicial to the general health of the community. In the fat-loft of bygone days many tons of animal fat, as it came from the shambles of the butcher, were suspended from wooden beams for days, or even weeks, in order that the membranous and interstitial matters might become partially destroyed, or "broken up," by the kindly exertions of the domestic blow-fly and slow putrefaction.

Since that period, however, scientific men have introduced many important improvements into the art of candle-making, and it has gradually become a chemical manufacture of first-rate importance, conducted upon scientific principles. As far back as the year 1830 the late Mr. Charles Watt, the inventor of the well-known process for bleaching palm-oil with chromic acid, devoted much attention to the refining of tallow, with the view to dissolve the cellular tissues attached to animal fats, by chemical means, and so successfully was this accomplished by a process which he subsequently patented that the system of "storing" candles for many months, then in vogue, was abandoned wherever the new process was adopted. The process referred to was the precursor of many subsequent modifications, which will be considered hereafter.

There are three methods of making candles, namely, by "dipping," "moulding," and "rolling." The cheaper kinds of tallow candles are produced by dipping; stearine, "composite," and paraffin candles are moulded, and those prepared from wax are *basted* and rolled.

Before describing the various details of the manufacture, it will be necessary to direct attention to the materials employed, and the methods adopted to render them suitable for candle-making. The principal materials used in candle-making are tallow, that is refined animal fats, stearin, palm-oil, paraffin, ozokerite, wax, and fatty acids. Chevreul and Braconnot, whose investigations concerning the composition of fatty bodies have been of the greatest service, both to the soap-maker and candle manufacturer, proved that fats, as they occur in nature, are a combination of the simple fluid and solid fats, olein, stearine, and margarine in variable proportions, the fusibility of the compound fat varying as the liquid or solid constituents preponderate. Fats are thus classified:—1. Unsaponifiable fats—as paraffin, for example—which are unchanged when boiled with a solution of caustic potash. 2. Saponifiable fats (also called *glycerides*), which, when boiled, or left long in contact with alkaline solutions, are gradually resolved into (*a*) fatty acids, which combine with the alkali, forming soap, water, and (*b*) the tri-atomic alcohol glycerine. 3. Fatty acids combine with most bases, forming salts, and can be displaced by stronger acids, floating upon warm aqueous solutions as an oily fluid.

Fatty acids, according to their respective boiling points, are designated *volatile fatty acids* and *fixed fatty acids*. Heintz, whose researches corroborate those of Chevreul, found that the fats of tallow and palm-oil essentially consist of stearic, palmitic, and oleic acids, in combination with glycerine, stearin, palmitin, and olein, and are consequently glycerides. In one respect, however, he differs from Chevreul, inasmuch as he considers the margaric acid obtained by saponification to be a combination of palmitic and stearic acids, a view which is now generally accepted.

Tallow.—The animal fats chiefly used in candle-making are mutton and beef suets, and consist of stearin, palmitin, and olein, the stearin, however, preponderating, but varying in percentage in different species of animal, the nature of its food, and its age. Mutton fat contains more stearin than beef. The melting point of beef fat is 100° F., while that of mutton fat is from 100° to 106° F. Melted mutton fat becomes solid at 100° F., but in solidifying its temperature rises to 111° F.

Rendering Tallow.—The rough fats, as they come from the butchers, require to be clarified, or *rendered*, as it is

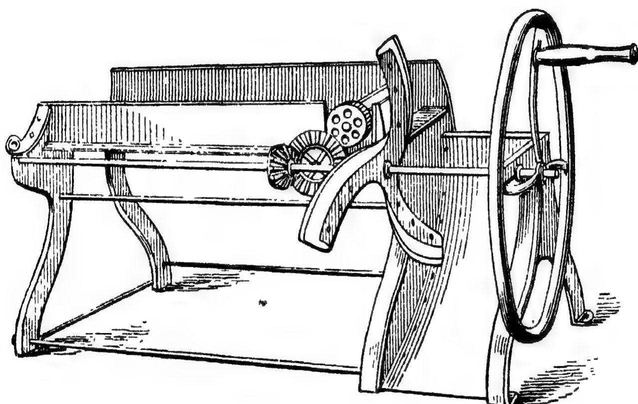


Fig. 39.

technically termed, by which process the pure fatty matters, or tallow, are separated from the membranous and cellular tissues which are attached to them. The fats are usually suspended from wooden beams in a well-ventilated loft to dry, after which they are subjected to a process of mincing, either by means of a series of revolving knives fixed to a table, and worked by hand (Fig. 39), or in larger establishments by machinery driven by steam power. The minced fat is next boiled, which in small works is conducted in an open pan or copper, care being

taken that the fire plays only upon the bottom of the pan, to prevent the fat from being burned or discoloured.

It is usual to first put a quantity of *rendered* tallow or water into the pan, and when this is melted the minced fat is introduced, the whole being kept stirred until the fat is completely liquefied. The melted fat is next removed by means of a ladle or swimmer, and passed through a brass sieve, or wicker basket. The melted and strained tallow is now allowed to repose for a time, to allow further impurities to subside, and is afterwards conveyed to store casks until required for use. The solid residuum, called "cracklings," retained by the sieve, is next subjected to moderate heat, and gradual but increasing pressure (Fig. 40), which squeezes out a greater portion of the remaining fat, leaving a hard cake, to which the name "greaves" is applied. By the above method of rendering tallow beef fat is said to yield—as a *maximum* product seldom attained—95 per cent. of tallow from ordinary rough fat, and 2 per cent. of refuse; and mutton fat 91 per cent. of tallow, and 4·5 per cent. refuse.

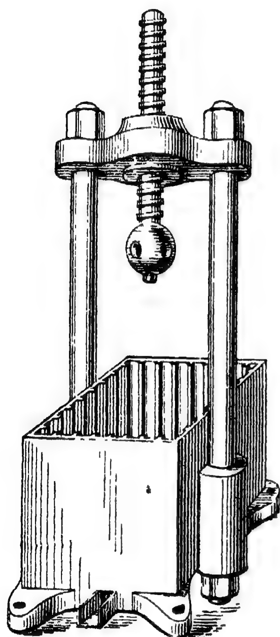


Fig. 40.

This crude method of rendering tallow is open to several objections, amongst which may be mentioned the following:—In an open copper it is difficult to keep the heat uniform; again the cellular tissues do not become completely broken up, while they acquire such extreme hardness that the press is unable to squeeze out the whole of the fat. In large establishments the open copper is

dispensed with, and steam-tight cylindrical boilers substituted, besides which chemical substances are introduced (as first suggested by Mr. Charles Watt*) which facilitate the breaking up of the cellular and membranous matters, thus affording a higher yield of tallow. For this purpose Mr. C. Watt employed dilute sulphuric acid, to which a little nitric acid was added, as also a small quantity of

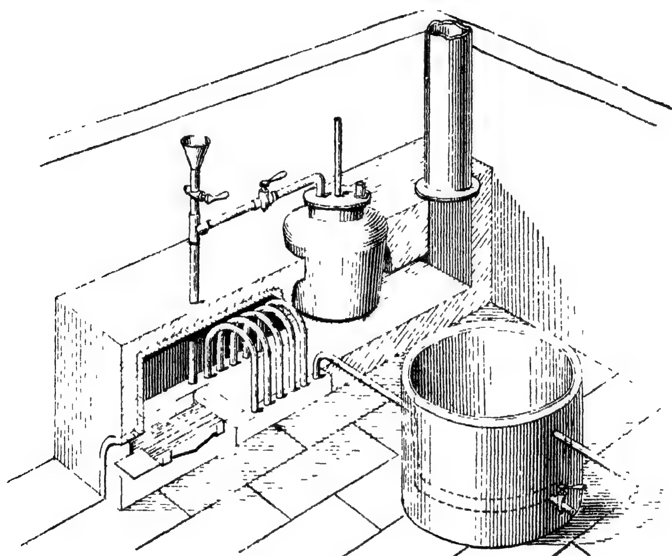


Fig. 41.

bichromate of potash, these ingredients being added to the fat when in a melted state. The tallow thus treated was afterwards well washed. By D'Arat's method the crude fat is boiled by steam, with about one-fourth its bulk of water, acidulated with from 2 to 3 per cent. of sulphuric acid, in an open or loosely covered lead-lined vessel. When a steam-tight boiler is used, with a pressure of 50 to 60lbs. per square inch, it is said that the yield of

* Patent, March, 1836.

tallow is about 12 per cent. more than is obtained by any other method.

An apparatus for rendering fat by steam has been introduced by Messrs. Merryweather and Sons, of Long Acre, London, an illustration of which is given in Fig. 41, to which the reader is referred.

The tallows of commerce, before being used for making candles, generally require to be subjected to a further refining process, which may be effected by either of the following methods:—1. The tallow being melted, 2 per cent. of sulphuric acid, largely diluted with water, is introduced, and the whole kept briskly agitated for some time, after which the tallow is allowed to cool slowly. The resulting cake is next re-melted with a large quantity of boiling water to thoroughly wash it. 2. Steam is blown through the melted fat for half an hour or so; it is then allowed to cool and settle. 3. A little nitre in solution is added to the melted fat, with constant agitation, and soon after a little dilute sulphuric acid added, or a solution of bisulphate of potash. 4. A small quantity of dilute nitric acid is added to the melted fat. 5. Chromic acid, or a mixture of bi-chromate of potash solution and dilute sulphuric acid is used.

In each of the foregoing methods the tallow requires to be well washed with hot water or steam, and should be allowed to cool slowly, so that the chemicals may effectually deposit.

Lard.—The fat of the hog, or lard, is much used in America in the manufacture of candles, after the olein has been expressed from it. The quality of the lard, however, varies according to the nature of the animal's food; thus the fat of hogs fed upon grain or potatoes is hard, and possesses great body, as is also the case when the animals have been fed upon malt; but the fat of hogs which have been fed upon brewers' or distillers' waste possesses but little body, is soft and oily, and of a yellowish colour, having a melting point of only 81° F.

Stearin is the solid portion of fats, and is insoluble in alcohol. The commercial article, however, is in reality

stearic acid, and is produced by several different chemical processes, which will be presently described. Tallow stearin, or, as it may be termed, *real* stearin, was formerly much used in candle-making, and is obtained as follows:—Refined tallow is first melted, and then allowed to cool very gradually, being kept constantly stirred until it has become solid, a process which used to be termed *packing the tallow*. The material thus treated is next put into bags, and submitted to gradual but increasing pressure, when a large proportion of the olein becomes squeezed out, leaving the stearine in hard cakes, which after being melted will form "mould" candles of excellent quality. *Stearic acid* (commonly called *stearine*) is prepared on the commercial scale by either of the following methods:

I. **Lime Saponification Process.**—Ordinary tallow, or a mixture of tallow and bleached palm-oil, boiled in a large wooden vessel, fitted with a perforated coil of steam pipes, by means of steam at a high pressure, with about 15 or 16 per cent. of hydrate of lime—that is, recently slaked lime—for three or four hours, or until perfect saponification takes place, by which a lime soap is formed; the whole is then allowed to cool, and the product, which is a compound of stearate and palmitate of lime, is afterwards removed to another wooden vessel, and treated with about four parts of sulphuric acid—previously diluted with water—to every three parts of slaked lime originally used in the saponification, and the action is promoted by the aid of steam, heat, and constant agitation. The material is then allowed to rest, when the liberated fatty acids rise to the surface, and the sediment—sulphate of lime and water—collects at the bottom of the vessel. The fatty material is next ladled into another vessel, in which it is well washed with water, steam being blown into it to assist the process. It is then allowed to cool, and is afterwards reduced to shavings by means of a series of knives worked by machinery, and the shavings are then placed in canvas bags, which are submitted to the action of a powerful hydraulic press, by which a considerable portion of the oleic acid is squeezed out. The

resulting cakes of stearine (stearic acid) are again submitted to the action of steam and water, and once more cooled, and then reduced to a coarse powder, which is again submitted to the joint action of steam and pressure, the cakes being placed in bags made from goats' hair. The heat and pressure are kept up for about two hours, by which time the remainder of the oleic acid is removed. The refined cakes are next re-melted by steam, and sometimes a little wax is added to destroy the crystalline structure of the stearic acid. The material is finally cast into blocks for the market. The melting point of the resulting product is from 132° to 135° F.

II. **Acidification Process.**—It had long been known that fats are decomposed by concentrated sulphuric acid, in a like manner to that which is effected by caustic alkalies, but while the acids enter into combination with the fatty acids, setting free glycerine, it was held by Frèny that sulphuric acid combined with both, producing from the acids of the fat sulpho-stearic, sulpho-palmitic and sulpho-oleic acids, and, from the glycerine, sulpho-glyceric acid. Dr. Bock, however, entertains a different view of the reaction, which he explains as follows: "By the lime saponification method, lime soap is formed, and extraction of the glycerine is rendered possible. By acidification, the whole process is effected at once. When properly conducted, the fat, washed out with water, always remains as a neutral fat, whereas, when concentrated sulphuric acid is used, not a trace of glycerine is left. Acidification, when properly conducted, is only a preliminary operation, intended to break up, or carbonize, albuminiferous matters. With due care, only the envelopes of the cells are blackened, and these are soluble neither in fat nor in fatty acids. The production of a really black solution is only an evidence that a certain part of the fat has been charred, which should be avoided under all circumstances. . . . By proper acidification, the neutral fat is only uncoated, as it were, and freed from the cells, or at least the latter are so ruptured as to allow of the easy exit of the fat. This latter is then in a condition

to be decomposed, an operation accomplished in a much shorter time by the chemical equivalent of acid—from 4 to 4·5 per cent.—and the necessary water. After allowing the glycerine water to escape, the fatty acids appear more or less black; they may now be distilled. Their melting-point varies from 120° to 130° F." The real value of the new method consists in dispensing with distillation. The object of this operation is the removal of the black colour, or rather of the black-coloured matters, by super-heated steam. These black matters are the partially carbonized albumen cells, which swim about in the fatty acids, because the specific gravity of the two bodies is about the same. The difficulty is overcome by oxidising the mass, by which the specific gravity of the cells is raised from ·9 to 1·3. They are thus precipitated, and the fatty matters can be washed off. The subsequent cold and hot pressing are the same as with ordinary methods.—*Carpenter.* The acidification method, combined with distillation, is the process largely used at Price's Candle Works, Battersea, London.

Palm Oil, or Palm Butter, is obtained from the fruit of several species of palm, but chiefly from *Elais Guineensis* and *E. melanæocca*, or Guinea oil palms. The oil, which has the consistence of butter, is of an orange-red colour, and has the odour of violets. It may be bleached by exposure to the sun, by chlorine, chloride of lime, and by strong sulphuric or nitric acids, but when bleached by the substances named, the colour becomes restored to a great extent when the bleached oil is subjected to the action of an alkali, as in the process of soap-making. The only successful method of bleaching palm-oil, by which the colour is not only destroyed, but removed, is by the well-known "chromo process" of the late Mr. C. Watt.

Cocoa-nut Oil, or Cocoa Butter.—This oil is chiefly used in the manufacture of night lights, its melting point being too low for ordinary candles.

Piney Oil, or Tallow, obtained from the seeds of *Vateria indica*, is a solid fat which melts at from 95° to 97°

F. It can scarcely be deemed a useful material for candle-making.

Waxes.—Under this head is classed:—1. Animal waxes; 2. Vegetable waxes; 3. Mineral waxes. Animal waxes include bees' wax and spermaceti. After the honey has been removed from the cells of the honeycomb, the latter is melted in water, at a moderate heat, and the liquid mass is then strained, and the clear wax afterwards melted and cast into cakes or round tablets. Bees' wax is brittle at 32° F., becomes soft and plastic at 88° to 85° F., and its melting-point is from 145° to 155° F. The commercial article is frequently adulterated with farina, resin, and mutton suet, or stearine. Crude wax, especially that which is imported, is generally loaded with dirt and other foreign matters, to free it from which it requires to undergo a process of refining, which is conducted as follows:—The crude wax, with about 5 per cent. of water, is placed in a clean bright copper or stoneware boiler, which should be fitted with a steam jacket. When the wax has become perfectly liquid, and after boiling for a few minutes, a little oil of vitriol is sprinkled over the surface, in proportion of 5 or 6 fluid ounces to each cwt. of wax. Great care is necessary, however, otherwise the wax will froth up and boil over. The acid should be well spread over the whole surface of the liquid, in moderate quantities at a time. When the whole of the acid has been introduced, the steam must be turned off, and the pan covered up and left for a few hours to settle and cool.

When sufficiently cool for *moulding*, the wax must be gently skimmed with a hot ladle, and then ladled or otherwise drawn off into hot tin "jacks," from which it is poured into basins, where it is left until cold. When the refined wax has been withdrawn from the sediment, the remainder in the melting-pan is allowed to become cold, and the cake, or "foot" is removed under the surface, and the cake may then be re-melted and strained through canvas. It is usual, however, to treat these cakes in a second operation.

Bleaching Wax.—Two methods of bleaching wax are

adopted, one being *atmospheric*, and the other *chemical;* the former is, however, the only method by which the material can be bleached without suffering injury. In *atmospheric* bleaching, the wax is first reduced to small pieces, which are placed in a vat furnished with a perforated coil of lead piping, through which steam is admitted. A small quantity of very dilute oil of vitriol, in the proportion of 1 lb. of the concentrated acid to each ton of wax, is added, and the contents of the vat then boiled for some time with brisk agitation, by which the impurities separate, and finally deposit to the bottom of the vat. The wax, which has now become "cleared," is next conveyed to a tank, the bottom of which is perforated with holes about ¼-inch in diameter. The wax, trickling through these holes in thin streams, passes on to a revolving drum, one half of which is immersed in a tank of cold water. As the drum revolves it carries with it a layer of water, upon which the wax flows, and thus becomes divided into very thin strips or ribbons, which being carried by the revolving drum under the water, become dislodged, and as they rise to the surface they are removed by means of a rake, and are afterwards spread thinly and evenly on sheets of canvas, placed in the open air, so that they may become exposed to the combined influence of the sun and the atmosphere. They are thus left, being frequently turned to expose fresh surfaces to the sunlight, and also frequently sprinkled with water—from 4 to 10 weeks, according to the weather. During the above period the ribbons are re-melted once or twice, divided into ribbons as before, and again spread out to bleach. All varieties of wax do not yield equally to the above, or natural, method of bleaching; some are said to be "stubborn," while others, which more readily yield to the influence of sunlight, are termed "kind."

Pe-la, or Chinese Wax.—This material is formed upon the young branches of *Fraxinus Chinensis*, or wax-tree, by an insect (*Coccus pe-la*). After being scraped from the trees, the crude wax is cleansed from impurities by spreading it on a strainer, which covers a cylindrical vessel

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placed in a cauldron of boiling water. When the purified wax congeals, it is fit for the market. It has a crystalline structure; its melting point is about 180° F., and is harder than spermaceti. In China candles are made from this material, but more generally it is blended with softer fats, while sometimes it is used as a coating for materials which melt at a lower temperature. It is sometimes coloured with alkanot root.

Spermaceti.—This beautiful fatty material is obtained from oil taken from the head of the Sperm whale (*Physeter macrocephalus*), and which, after death, separates as a solid. Spermaceti is also obtained from the blubber or body-fat of the whale, after melting and cooling, when the solid material separates and deposits. The method of separating the spermaceti crystal from the oil has been fully described in the *Jury Reports, Exhibition*, 1851.* Purified spermaceti is white, crystalline, or scaly, brittle, inodorous, and almost tasteless. Its melting-point is from 110° to 120° F. When spermaceti has been purified by digesting with alcohol repeatedly, what remains is the *cetim* of Chevreul, or pure spermaceti, the boiling-point of which is 616° F., at which temperature it distils without alteration.

Vegetable Waxes.—There are several substances which have been classed under this heading, which are in reality fats. *Carnauba*, or *stone-wax*, however, may more properly come under the designation of wax, from its great hardness, as compared with ordinary fats. It is obtained from the leaves, stalks, and berries of the Carnauba palm (*Copernicia cerifera*), in which it occurs as a thin film upon the leaves, &c., which are collected and dried, when the wax is peeled or boiled off, then melted in earthen pots, and turned out when cold. The wax is of a yellowish colour, and very hard and brittle. When bleached it is perfectly white, and has a melting-point of from 182° to 188° F. It is occasionally employed to harden candles, but not more than 2 per cent. can be used for this purpose, otherwise the candles are apt to crack. *Japan-*

* *Jury Reports*, Exhibition 1851, p. 626.

wax, so-called, is in reality fat. It is obtained from the fruit of *Rhus succedanea*, or *R. vernicefera*. The fruits are ground by millstones, and the shells and epidermis are separated by sifting and winnowing, and the mass is then heated in canvas bags over boiling water to melt the fat, which is then pressed out. The crude tallow is now boiled with dilute ley, whereby it becomes granular, and more readily bleached. Bleaching in the sun, and subsequent melting, are repeated until the product is a pure white. Its melting-point is from 125° to 127° F. when old, and about 107° F. when recently solidified.

Chinese Vegetable Wax, or **Tallow,** is obtained from the kernels of the nuts of *Stillingia sebifera*. It is a white, hard solid, the melting-point of which is about 104° F.

Myrtle Wax, or **Tallow,** is a greenish coloured fat, obtained by boiling the coating of the berries of *Myrica cerifera*, in Louisiana, and *M. cordifolia* in the Cape of Good Hope. It consists of palmitic and myristic acid, and a little glycerin, and has a melting-point of 116° to 120° F.

Palm Wax is obtained from the trunk of *Ceroxylon Andicloa*. According to some writers, it does not melt below the temperature of boiling water, while others give the melting-point as about 161° to 186° F.

Mineral Waxes—Paraffin.—This important candle material is found native, but it is chiefly obtained by the distillation of petroleum (especially that from Rangoon), several kinds of coal, peat, and wood tar. It is a white translucent body, melting at about 110° F. and upwards, according to its source, and burns with a remarkably white and bright flame. Its illuminating power is greater than that of any other candle-making material, surpassing even spermaceti in this respect. Crude paraffin is purified by several methods, and an interesting description of them fully given by Mr. R. Gervet in the *Journal of the Society of Chemical Industry*, 1887, p. 356.

Ozokerit, or Fossil Wax.—This mineral product occurs in various localities in the Tertiary Strata, but chiefly in or near the coal measures, the present and most extensive

deposits occurring at Trohobyes and Boryslaw, in Galicia, and in the island of Tcheleken, in the Caspian Sea. It usually occurs as a compact brown substance, though sometimes it is yellow, and occasionally black. Ozokerit has been extensively used by Messrs. Field, of Lambeth, London, in the manufacture of candles, and the method of refining the crude article has been fully described by Mr. Leopold Field.*

Wicks.—An important feature in connection with the candle-making industry is the preparation of the wicks for the various kinds of candles required by the consumer. For ordinary tallow or "dip" candles, the wicks are made from the ravings of Turkey skein-cotton, lightly twisted, the threads being known in the trade by the Nos. 16 to 20, that is 16 to 20 "hanks" of the threads weigh 1lb. Twisted wicks are only used for tallow and wax candles, while plaited or *braided* wicks are used for all the better materials of which candles are composed, as stearine, composite, paraffin, &c. The plaited wick, which was introduced by Cambacères, has for its object the doing away with the necessity of snuffing. One principal effect of plaiting the wick is to cause it to bend over while the candle is burning, by which its end becomes directed to the outer part of the flame, where, being exposed to the action of atmospheric oxygen, it gradually consumes, and therefore needs no snuffing. The bending of the wick is promoted (1) by twisting it with one strand shorter than the others, which becoming somewhat stretched during the moulding, again contracts when the fat melts, causing the wick to bend over; (2) or the same end is effected by plaiting the cotton into a *flat* wick, which naturally assumes the requisite curve during the combustion of the candle.

Many substances have been introduced into plaited wicks to prevent the too rapid combustion and smouldering of the wick after the candle has been puffed out; the process is termed *pickling*, and consists in dipping the wicks in subnitrate of bismuth, ground up with oil

* "Cantor Lectures," January, February, and March, 1883.

(Palmer's patent), or in a weak solution of borax or boracic acid; other substances have also been used for this purpose.

Making the Candles—Dipping.—Four or more of the Turkey skeins, according to the intended thickness of the wick, are wound off into bottoms or clues, and afterwards cut by a simple machine into lengths corresponding to those of the candles to be made. The lengths are then doubled, twisted, dipped into melted tallow, and rubbed

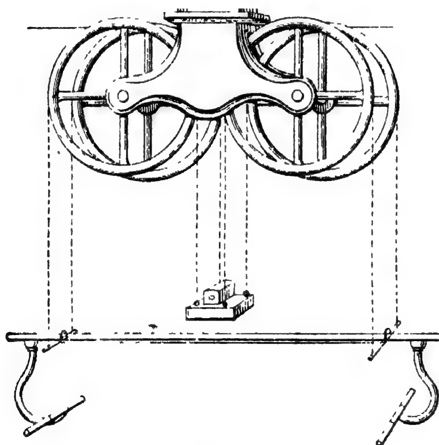


Fig. 42.

between the palms of the hands until they are perfectly straight, the loops are then passed through a long, round, wooden rod, termed a *broach,* side by side, and as equi-distant as possible. The broaches, when supplied with wicks in this way, are then placed upon a frame, hung above the cistern, about eight of them being the usual number for the dipping frame. This frame, an illustration of which is shown in Fig. 42, is capable of being raised or lowered by a simple movement of the hands at will. The workman now gently and steadily presses the frame

downwards, by which the wicks become dipped into the melted tallow, and the counterpoise attached to the machine, when the pressure of the hands is relaxed, causes the frame to rise out of the trough. The frame is next carefully removed and placed on a dripping frame, or *post*, beneath which is a shallow tray to receive the drippings from the wicks. A fresh batch of wicks is then treated in a similar manner, but for the second and subsequent dippings the tallow requires to be cooler than that employed in the first instance, about 100° to 110° F. being the usual temperature, or at a point when it is disposed to solidify at the sides of the trough. After each dipping the candles are allowed to cool sufficiently to allow the next layer of tallow to adhere to its predecessor without disturbing it. These repeated dippings are continued until the candles have acquired the necessary thickness and weight. The last dipping is conducted with great care, to ensure as perfect uniformity of surface as possible. In the event of the ends of the candles becoming too thick, the workman dips them for a few moments in the warmer tallow bath, when the excess of tallow becomes melted away. The finished candles are then transferred to another apartment to undergo the processes of *pounding* and tying. For the former purpose a pair of scales are placed on a bench, on which also is laid a quantity of the new-made candles. A lad then takes in hand a certain number of candles, six or eight, for example, according to whether they are 6's or 8's, in technical phraseology, that is, running six or eight to the pound, and placing the proper number in the scale, sees at a glance whether they fairly counterbalance the 1lb. weight in the opposite scale-pan. If the weight be in excess, he quickly selects a thinner-looking candle from the bench, removes a stouter one from the scale-pan, and in this way quickly obtains a fair average weight. A short length of string is then passed through the loop of the wicks by means of a bodkin, and the string then tied into a knot.

Moulding.—On the small scale candles are moulded by hand frames (see Fig. 43). The wicks being inserted in

the moulds are secured in their places by a straight iron wire passing through a hole in the trough of the frame; the top end, or that which passes through the conical cup of the mould, is fixed by means of a small wooden peg inserted into the orifice of the cone. Eight, twelve, or more of these moulds are fixed into the frame. The melted stearine, tallow, paraffin, or other material, is poured into the trough of the frame from a small can, called a *jack*, when the moulds at once become filled. The frames are then set aside until cold, when the wires are withdrawn, and the surplus stearine scraped from the top of the

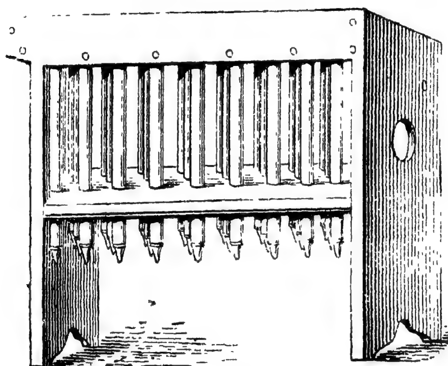


Fig. 43.

frame by means of a small wooden spade or trowel. The workman then takes a small hooked instrument, termed a bodkin, which he inserts into the loop of each wick, and pulls the candles about half way out of the mould.

When the candles are all thus set free he then draws them out of the moulds, one or two at a time, and conveys them to the warehouse. In large establishments the candle-moulding machine, or continuous-wicking machine, is used, and has almost entirely superseded the hand frames. These machines, originally of American design, have been improved by our own engineers, and are now extensively adopted by candle manufacturers. Various

types of these machines are described in another place, and the directions for commencing the use of the machine are thus given by Mr. E. Cowles:—1. Raise the tip moulds to the top of the main moulds. 2. Insert a very fine wire, doubled, and of sufficient length to go through the tip mould and piston, and extend below the piston about 6 in.; insert the end of the wick in the loop made by the doubled wire, and draw up the wick through the tip mould, and secure it in any convenient manner for the first pouring; then lower the pistons as far as they will go, and pour in the material, and, when cold, shave off the *butts;* then place the racks in a vertical position, with the tip bars thrown out; the crank is then turned, and the candles ejected into the racks; the racks are then closed by turning the handle, and the tip of each candle is held precisely over the centre of its mould, now the piston-block with pistons is let down, and the wicks are held by the candles above and spools below, passing through the pistons and through a small aperture in the centre of the tip mould they are all strained exactly in the centre of the moulds, and all is ready for the melted material again, which, when cold, the wicks are severed below the tip bars, and the racks with the candles are then removed to any desirable place.

In moulding stearine the cakes of stearic acid are melted, and from 3 to 5 per cent. of wax, or 10 to 20 per cent. of paraffin, added, to prevent the stearic acid from crystallizing, or to "break the grain," as it is termed. These materials are well mixed by stirring, and when the material is nearly on the point of solidifying, it is passed into the moulds, which are previously heated to about 120° F. To produce a polished surface on the candles, hot and cold water should be alternately passed into the waterway of the machine.

In moulding *sperm candles,* as those produced from spermaceti are termed, the material is first melted and heated to a temperature approaching that of boiling water; it is then run into the previously heated moulds, and in order to preserve its transparency, it should be cooled as

quickly as possible. Since this substance, like stearin, has a highly crystalline texture, it is usual to mix with it about 3 per cent. of wax. Paraffin candles may be moulded in the same moulds as those used for the two latter materials. In this case, however, the moulds should be heated to about 150° F., or slightly above the melting point of paraffin, and a few moments after the moulds have been filled they should be *suddenly* chilled with cold water, the object of this being to prevent the material from crystallizing on the surface, which renders it opaque instead of being clear and transparent, upon which much of the beauty of the material depends. To render paraffin less liable to soften and bend, 5 to 10 per cent. of stearic acid is added.

Composite Candles.—This material, originally patented by Mr. J. P. Wilson, is a mixture of cocoa-stearine and stearic acid. The compound is rather greasy to the touch, but yields a bright light.

Night Lights.—These substitutes for the once famous rushlight are prepared from stearine and cocoa-stearine, or from cocoa-nut oil and palmitic acid in varying proportions. The wick, which is exceedingly thin, is fastened to a square piece of tin foil, termed the *sustainer*, and secured in the centre of the small case by a drop of wax. These cases, thus prepared, are placed in rows and then melted material poured in from a tin can or *jack*. By another method the night light is made of a somewhat harder material, chiefly composed of palmitic acid, no case being used, but the light is placed in a small glass. The melted material is run into a special moulding frame, and when cold the night lights are turned out ready perforated for a wick, which is afterwards inserted by hand.

Wax Candles.—For making these candles the wicks are made of unbleached Turkey cotton. Wax is not suitable for moulding in the ordinary way, owing to its liability to adhere to the moulds, and also contracting to a great extent in the act of cooling. To prepare the candles, the wicks are first warmed in a stove, and are then suspended upon a wooden or metal hoop slung over a

bath of melted wax; the workman, provided with a small ladle, dips this into the liquid material, and, moving the hoop gradually round, he pours the wax over each wick in succession, at the same time giving the wick a slight turn with his finger, so that the material may flow equally on all parts of the wick. The hoop is kept gently revolving in this way, and the wicks *basted* with the wax until the candles have attained about one-third of their required size; the hoop is then placed on a rack, and while the wax is cooling on this, a second hoop is taken and treated in the same way. The first batch of candles is afterwards again basted with wax until the candles are about half the proper thickness. While still warm the candles are next rolled upon a marble slab wetted with water, by means of a rolling board, by which smooth and uniform cylinders are obtained. The candles are again suspended from the hoop in reversed position, and basted with the wax as before until they have acquired the requisite thickness, when they are again rolled on the slab, and cut to uniform lengths, and their tops trimmed with a piece of wood. Large wax candles, such as are used for ecclesiastical purposes, are made by laying the wicks on a sheet of wax, then folding the wax over it, and then rolling as above, other layers of wax being rolled on until the required thickness is obtained.

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